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OFFICERS' HANDBOOK ON MILITARY TOPOGRAPHY (THIRD EDITION, CORRECTED AND EXPANDED)

By

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COUNTRY: USSR

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13. ABSTRACT

This handbook encompasses the range of questions that makes up the subject of military topography. It is intended for officers in all branches of the Armed Forces and combat arms.

Two new chapters are included: "The Use of Navigational Equipment in Orientation," and "Methodological Advice on Organizing and Conducting Lessons on Military Topography"; examples of topographic maps at scales from 1:25,000 to 1:1,000,000 are provided.

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NOTICE

GRAPHICS NOT REPRODUCIBLE

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The following definitions apply for the transliterated organizational entities included in the text:

chast'	[voinskaya chast'] - Administrative, line, and supply unit (yedinitsa) of the [branches] of troops, which has a number and banner, e.g., a regiment, separate battalion (batal'on, division) and troop organizations equal to them.
ob"yedineniye	[operativnoye ob"yedineniye] - Large-scale unification of various soyedineniye of the branches of troops, which is nonpermanent in composition and is intended to conduct operations in a war.
podrazdeleniye	Troop unit of permanent organization and homogeneous composition in each branch of troops, which unit forms a larger podrazdeleniye or a chast'.
soyedineniye	[soyedineniye voyskovoye] -- Combination (soyedineniye) of several chast' of one or various branches of troops into a permanent organization (division, brigade, or corps), headed by a command and a staff and including chast' and podrazdeleniye of auxiliary troops and services necessary for combat operations.
Source:	Russian-English Dictionary of Operational, Tactical and General Military Terms, 1958

AUTHORS' PREFACE

This handbook encompasses the range of questions that makes up the subject of military topography. It is intended for officers in all branches of the Armed Forces and combat arms.

The third edition as compared with the second edition includes a number of additions and changes.

1. Two new chapters are included: "The Use of Navigational Equipment in Orientation," and "Methodological Advice on Organizing and Conducting Lessons on Military Topography"; examples of topographic maps at scales from 1:25,000 to 1:1,000,000 are provided.

2. The contents of Chapter I, "General Information on Terrain and Methods for its Study," have been revised; questions of military geodesy, which have practical significance for the troops, are presented in greater detail; questions associated with allied disciplines (military geography, engineering, etc.) are presented in somewhat curtailed form.

3. The presentation of elementary procedures for ground orientation has been somewhat curtailed because of the widespread use of navigational equipment in ground vehicles by the troops, as well as because the Handbook includes a chapter on its use.

4. Examples of maps, tables of conventional signs, and a list of conventional abbreviations used on maps are printed for standardization and convenience in their practical use from finished forms of the handbook Conventional Signs on Topographic Maps of the USSR (author-compilers: S. S. Abramov, G. N. Nezhelskiy, and N. A. Nikitina; editor: V. A. Vishnyakov) published by RIO VTS (Editorial-Publishing Department, Military Topographic Service) in 1966.

The conventional signs are presented somewhat enlarged for better readability. Many conventional signs are presented in their new and old configuration because the troops use maps published in different years.

In revising the Handbook, the authors tried to give fullest consideration to the remarks and desires expressed concerning the second edition (in the periodical press, in public discussions, in personal talks and letters). In this connection, we consider it our duty to express our thanks to comrades V. A. Vishnyakov, Ye. D. Golikov, V. F. Rubakhin, V. V. Ofitserov, A. F. Lachin, A. M. Kuprin, I. M. Prishchepe, B. Ye. Byzov, S. M. Shlezinger, and others whose assistance and participation furthered improvement in quality and hastened the preparation of this edition of the Handbook for printing.

Chapter I

General Information on Terrain and Methods for Its Study

(Alphabetical-Lexicographic Presentation)

АВТОГУЖЕВЫЕ ДОРОГИ
AVTOGUZHEVYYE DOROGI

Vehicular and horse-drawn transport road. Roads for the movement of vehicular or horse-drawn (wagon) transport. On topographic maps, they are divided into superhighways, improved highways, highways, improved dirt roads, dirt (country) roads, field roads, forest roads, and winter roads. (For the characteristics of all classes of roads listed, see the text in alphabetical order).

АВТОСТРАДЫ
AVTOSTRADY

Superhighways. The highest category of highway, with a strong surface of asphalt concrete or cement concrete. Roadway width of the superhighway is at least 14 meters, longitundinal slopes are up to 3°, and intersections with other roads are at various levels by means of crossovers.

АЗИМУТ
AZIMUT

Azimuth. The angle between the northern direction of a meridian passing through a given point and the line of direction to an observed (designated) object:

geodesic angle - the angle on the surface of the earth ellipsoid between the northern direction of the meridian passing through a given point and the line of direction to the object; it is determined by convering the true (astronomic) azimuth (see)* or geodetic Y-azimuth;

true (astronomic) azimuth - the angle between the direction of the true (astronomic) meridian and the line of direction to the object; it is determined on the surface of the earth from celestial bodies by means of special instruments (theodolites, etc.);

magnetic azimuth - the angle between the northern direction of the magnetic meridian (direction of the magnetic needle of a compass) and the station - object line of direction; it is measured by a magnetic compass or computed from Y-azimuth; the magnetic and true azimuths of the same line of direction differ by the amount of declinarion of the magnetic needle (see);

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*(See) - indicates that the explanation for a particular word or group of words (set with letters further apart than usual in the original text) must be consulted elsewhere in the alphabetical-lexicographic presentation in this chapter.

back azimuth - the azimuth of the object-station line of direction; it equals the direct azimuth (station-object line of direction) plus 180°.

Azimuths are read in a clockwise direction from 0 to 360° in military topography and geodesy.

АКВЕДУК
AKVEDUK

Aqueduct. A bridge-like structure for the crossing of water supply lines and conduits over deep ravines, river valleys, railroads, and highways.

АЛЬПИЙСКИЙ РЕЛЬЕФ
AL'PIYSKIY REL'YEF

Alpine relief. A type of mountain relief which rises above the snow line. It is characterized by abrupt ruggedness, sharpness of form, pointed, serrated ridges, and pyramidal, rocky summits.

АНОМАЛИЯ МАГНИТНАЯ
ANOMALIYA MAGNITNAYA

Magnetic anomaly. An area with sudden changes in the amount of declination of the magnetic needle. As a rule, these changes are caused by the occurrance of ores which possess magnetic properties. The use of a magnetic compass in areas of magnetic anomaly is accompanied by a risk of the loss of orientation since the compass readings may change by as much as the opposite direction even with a short distance from one point to another. Areas of magnetic anomaly are shown on topographic as well as special maps and diagrams.

АРТЕЗИАНСКИЕ ВОДЫ
ARTEZIANSKIYE VODY

Artesian water. Underground water located between water-impervious strate or circulating along fissures and cavities in solid rocks. The water in the lower part of the bend is under great pressure where the strata are folded. If a drilled well is drilled to the layer containing the water, the water rises upward and even gushes out as a spout.

АРТЕЗИАНСКИЙ КОЛОДЕЦ
ARTEZIANSKIY KOLODETS

Artesian well. A drilled well which provides an outlet for artesian water; artesian wells reach a depth of 2,000 meters or more.

АРТИЛЛЕРИЙСКИЙ ЦЕЛЛУЛОИДНЫЙ КРУГ
ARTILLERIYSKIY TSELLULOIDNYY KRUG

Artillery protractor. An instrument for the measurement of angles in mils on a map (plan); value of a division is 10 mils.

АРЫК
ARYK

Irrigation ditch. The local name of an irrigation ditch in Central Asia.

АСТРОНОМИЧЕСКИЕ КООРДИНАТЫ
ASTRONOMICHESKIYE KOORDINATY

Astronomic coordinates. Geographic coordinates (latitude, longitude) determined from celestial bodies.

АЭРОСНИМОК
AEROSNIMOK

Aerial photo. A document of aerial photography - the photographic image of the terrain (objects);

vertical aerial photo - obtained as a result of vertical aerial photography (See); the scale of a vertical aerial photograph of flat and hilly terrain is practically constant and all measurements on it may be made by instruments and procedures adopted for work on a map;

oblique aerial photo - obtained as a result of oblique aerial photography; the scale of an oblique aerial photo is essentially varied (large in the foregound and being gradually reduced toward the background); special methods and instruments are employed in measurements and plotting on an oblique aerial photo;

vertical-oblique photo (panoramic photo) - obtained as a res8lt of vertical-oblique photography; in its properties, in its central portion it is similar to a vertical aerial photo and is similar to an oblique photo along the sides;

continuous-strip [shchelevoy] aerial photo - obtained as a result of aerial photography with a special (slit) aerial camera; it represents a continuous (without discontinuities) photographic image of a strip of terrain in the form of a strip for the entire length of the exposed photographic film; continuous strip aerial photos may be vertical and oblique; their measurement properties differ somewhat from the properties of regular (frame) aerial photos - the transverse and longitudinal scales of the picture may differ by 10% or more;

spectrozonal photo - a photographic image of objects in artificial colors; most often one color (usually blue) corresponds to the spectral zone of visible rays (this color portrays objects represented in regular black and white aerial photos by a gradation of gray tones); another color (usually purple) corresponds to the spectral zone of infrared (heat) rays; the combination of the two images in one photo (visible and infrared zones) permits the finding of objects camouflaged in the color of the surrounding background, disclosing additional characteristics of terrain trafficability, etc.;

colored photo - a photographic image of objects in colors close to natural colors; its interpretative qualities are somewhat higher than black and white photos.

АЭРОСЪЕМКА
AEROSYEMKA

Aerial photography. Aerial photography for the purpose of creating and correcting topographical and special maps, as well as solving problems in land management, timber management, geological explorations, road surveys, etc.

АЭРОФОТОДОКУМЕНТЫ
AEROFOTODOKUMENTY

Aerial photo documents. Aerial photos (see), mosaics (see), photomaps (see), photocharts (see).

АЭРОФОТОРАЗВЕДКА
AEROFOTORAZVEDKA

Aerial photoreconnaissance. Reconnaissance of the enemy and terrain by means of aerial photography.

АЭРОФОТОТОПОГРАФИЯ
AEROFOTOTOPOGRAFIYA

Aerial phototopography. A technical discipline examining methods and means for creating topographic maps from aerial photographic materials.

The creation of topographic maps by aerial photographic methods includes: aerial camera work (photography of the terrain), photo laboratory work (processing the film and duplicating the aerial photos), geodetic work (tying the aerial photos to the terrain by determining the coordinates of individual points depicted on the aerial photo), photogrammetric work (determining directions, distances, and heights of the terrain from aerial photos and compilation of the map original).

БАЛКА
BALKA

Ravine. A depression with comparatively steep sod-covered slopes. In the souther European part of the USSR, these ravines [balka] are also called gullies.

БАЛТИЙСКАЯ СИСТЕМА ВЫСОТ
BALTIYSKAYA SISTEMA VYSOT

Baltic system of elevations. Computation of absolute elevations from the average level of the Baltic Sea which is taken as the origin for calculation on topographic maps of the USSR.

БАРХАНЫ
BARKHANY

Sand dunes, barkhans. Loose sandy hillocks, unfixed by vegetation, with the shape of a half moon and with convexity against the wind. They have a gently sloping windward side (5-10°) and a steep leeward side (up to 30-35°) and a sharp ridge. Moste often, the height of the sand dunes is 3-5 meters; however, dunes up to 50-100 meters high are encountered. The sand dunes are difficult to cross. The dunes may displace slowly because of the wind's action.

БЕРГШТРИХ
BERGSHTRIKH

See hachures [Ukazatel skata].

БЕРЕГ МОРСКОЙ
BEREG MORSKOY

Sea coast (coastal zone). The boundary between land and water which almost always represents a more or less broad strip of their continuous interaction.

БЕРЕГОВАЯ ЛИНИЯ
BEREGOVAYA LINIYA

Shore line. The boundary between land and surface of the water (water's edge). On maps, the shore line is shown: for the mean level - in bodies of water which have no tides, with high water - with the presence of high tide - low tide phenomena.

БИПОЛЯРНЫЕ КООРДИНАТЫ
BIPOLYARNYYE KOORDINATY

Bipolar coordinates. Linear or angular values which determine the position of a point on a plane relative to two initial points. These values may be the distances d_1 and d_2 from points A and B (fig. 1), interior angles α and β, or the azimuths of the lines of direction A'_M and A''_M.

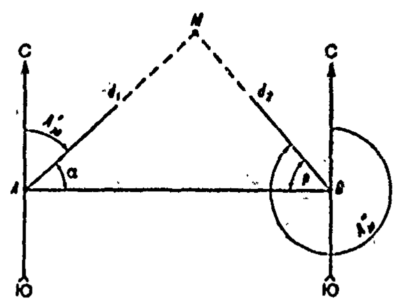


Figure 1. Bipolar coordinates.
Tops of arrows - north; bottoms of arrows - south.

БЛАНКОВАЯ КАРТА
BLANKOVAYA KARTA

Blank chart; base map. A topographic map printed in a pale tone in one or several colors. Blank charts obtained by enlarging topographic maps of a smaller scale are usually called enlarged blanks. The blank chart is used by staffs as the base for graphic documents.

БОЕВОЙ ГРЕБЕНЬ
BOYEVOY GREBEN'

Battle crest. Terrain near a watershed (see) from which the best downslope survey develops but troops and equipment are not in evidence against the background of sky when observed from the enemy side.

БОЕВЫЕ ГРАФИЧЕСКИЕ ДОКУМЕНТЫ
BOYEVYYE GRAFICHESKIYE DOCUMENTY

Graphic combat documents. Combat documents worked out graphically on a map, blank chart, overlay, or aerial mosaic.

БОЛОТА
BOLOTA

Swamp. A wet terrain sector with a layer of viscous soil (peat, mud) of more than 30 cm. Terrain sectors with a layer of wet soil less than 30 cm are called swampy land.

Swamps are divided: by feeding - into lowland swamps and upland swamps; by plant cover - into meadow swamps (primarily lowland), mossy swamps (primarily upland), and forest swamps; by structure - peat bogs and marsh swamps.

Lowland swamps (grassy, reed, and others) are located in the flood-plains of rivers, valleys, basins, and other relief depressions; they are fed primarily by ground water. Lowland swamps are usually greatly water-logged, dry out poorly in summer, and are negotiable with difficulty.

Upland (mossy) swamps are fed by atmospheric water; they are located on watershed expanses. Upland swamps dry considerably in the summer and their trafficability is somewhat better than that of lowland swamps.

Continuous peat bogs are bogs in which a continuous layer of peat occurs in the more or less hard soil. Continuous peat bogs with compact peat are more accessible in comparison with others.

Marsh swamps are those where the poorly bound peat mantle lies on a viscous, muddy sediment of the residues of organic substances (sapropel) or floats on the water (floating swamp). Marsh swamps are least accessible.

БРОВКА
BROVKA

Brow. The line of the bend of a slope below which the slope becomes steeper, for example, the edge of a gully, ravine, etc.

БРОД
BROD

Ford. A shallow section of a river accessible for crossing along the bottom. A ford may be discovered by means of reconnaissance, as well as from topographic maps, descriptions, sailing directions, and aerial photos. The most important signs of a ford are the approaches to it and roads, paths, and tracks which continue on the other bank.

БУГРИСТЫЕ ПЕСКИ
BUGRISTYYE PESKI

Hummocky sands. The sandy surface of the desert; hummocks up to 8 meters high with gently inclines, slopes fixed with sparse vegetation. Hummocky sands are easily trafficable.

БУССОЛЬ
BUSSOL'

Aiming circle. An artillery fire control instrument, which represents a combination of an optical and angle measuring instrument with a declinator (box with magnetic needle). Aiming circles made with a periscopic attachment (which permits observing from behind cover) are called periscopic artillery aiming circles (PAB).

ВЕЛИЧИНА МАСШТАБА
VELICHINA MASSHTABA

Scale value. The distance on the ground which corresponds to 1 cm on the map; for example, the scale value of a map of 1:100,000 is 1 km.

ВИЗИРОВАНИЕ
VIZIROVANIYE

Sighting. A procedure for eye surveying and working with a map on the ground:

direct sighting - sighting "on the object" along a straightedge placed on an oriented map against the point of the station;

reverse sighting - sighting "at one's self from the object"; the straightedge is placed against the depicted object on the map and directed toward the same object on the ground.

ВОДОРАЗДЕЛ
VODORAZDEL

Watershed, divide. 1. A characteristic relief line - a line which divides the surface runoff of two opposite slopes of a range. 2. A line (or strip) dividing the basins of two rivers, seas, or oceans.

ВОДОСЛИВ (Водсток)
VODOSLIV (Vodotok)

Runoff (catchment area). A characteristic relief line - a line along the bottom of a depression (valley, ravine, etc.) which is the axis of the channel of a river or of temporary streams of water.

ВОЕННАЯ ТОПОГРАФИЯ
VOYENNAYA TOPOGRAFIYA

Military topography. A military discipline concerning the means and methods of studying the terrain and orientation upon it in the preparation and conduct of combat actions.

The basic problems in a course of military topography are: tactical properties of the terrain, topographic maps and procedures for working with them, map study of the terrain, aerial photos of the terrain and their use in making an estimate of the enemy and the terrain, orientation on the ground, target indication, methods of measurement on the ground and the preparation of sketches, methodology for the topographic training of troops, and geodetic survey support of troops.

ВОЕННО-ГЕОГРАФИЧЕСКОЕ ОПИСАНИЕ МЕСТНОСТИ
VOYENNO-GEOGRAFICHESKOYE OPISANIYE MESTNOSTI

Military-geographic terrain description. See Terrain description [opisaniya mstnosti].

ВОЕННО-ГЛАЗОМЕРНАЯ С"ЕМКА
VOYENNO-GLAZOMERNAYA S"YEMKA

Military sketching by eye. The sketching of small sectors of terrain and routes of march with the use of simple instruments (compass, binoculars, engineer's scale, etc.), and with the wide use of estimation by eye. As theaters of military operations were supplied with topographic maps, military sketching by eye lost its independent significance. Now, its procedures are employed for plotting various objects on a map and the preparation of several graphical documents.

ВОЕННО-ТОПОГРАФИЧЕСКАЯ СЛУЖБА (ВТС)
VOYENNO-TOPOGRAFICHESKAYA SLUZHBA (VTS)

Military topographic service. One of the services of the Soviet Army. The VTS consists of headquarters organs, special chast', enterprises, military educational institutions, scientific-research organizations, and others. It is concerned with the geodetic survey preparation of probable theaters of military operations ahead of time, as well as with the geodetic survey support of combat training and the combat actions of troops.

ВОЕННО-ТОПОГРАФИЧЕСКОЕ ОПИСАНИЕ МЕСТНОСТИ
VOYENNO-TOPOGRAFICHESKOYE OPISANIYE MESTNOSTI

Military topographic description of the terrain. See Terrain description.

ВОЗДУШНОЕ ФОТОГРАФИРОВАНИЕ
VOZDUSHNOYE FOTOGRAFIROVANIYE

Aerial photography. Photography from flying machines (aircraft, helicopters, balloons, drones) using aerial cameras. It is conducted primarily for:

aerial reconnaissance of the enemy and terrain;

the compilation and correction of topographic maps;

checking the course of combat operations of troops and the results of the destruction of targets by the weapons of artillery, aviation, and missile troops;

survey preparations for missile troops and artillery;

checking the quality of camouflage of friendly troops.

The basic types of aerial photography are:

vertical - photography in which the optical axis of the aerial camera at the instant of exposure coincides with the vertical or deviated from it by a small angle, up to 3-5° with aerial photography for cartographic purposes and up to 30-25" in aerial reconnaissance;

oblique - photography in which the optical axis of the aerial camera deviates from the vertical by a considerable angle, usually more than 45°;

vertical and oblique (panoramic) - photography in which the aerial camera performs vertical and oblique photography during one exposure of a frame; this provides a great width of coverage of the terrain being photographed;

separate - photography of individual objects in one or two photos (airfields, bridges, etc.);

strip - photography of a strip of terrain (route of march, river, etc.) on a series of interconnected (partially overlapping) aerial photos;

area - photography of a terrain sector (defensive zone, fortified area, etc.) on a considerable number of aerial photos disposed in several routes;

night - photography with artificial illumination (pyrotechnical and electrical sources);

aerial motion picture photography (AKS) - photography with an aerial motion picture camera; performed only during the day and primarily from low altitudes for the reconnaissance of mobile objects and the terrain with the necessity for its study by a large number of people simultaneously; the viewing of the motion picture films is accomplished on a special instrument (motion picture interpreter) or by means of regular motion picture projectors;

continuous strip - photography with a special aerial camera; exposure of the film is performed through a narrow slit; in this, the film is rewound at the rate of the ground speed of the airplane at the scale of photography. Continuous strip photography is possible from any altitudes (including from low-level flight), under conditions of poor visibility, and at extremely high flying speeds (see aerial photo).

ВРЕМЯ
VREMYA

Time. 1. - Local time, the time at all places located along one meridian. 2 - Zonal time, a single time within the limits of a time zone (local time of the mean meridian of the zone). 3 - Statute time, the time introduced by the statute of the Soviet government on the territory of the entire Soviet Union from 16 June 1930; it is one hour ahead of zonal time.

ВЫСОТА
VYSOTA

Height, altitude. A positive relief form which is distinguishable against the surrounding terrain. On topographic maps, heights are usually accompanied by spot altitude readings, for example, "245.6," which is

used in target indication; in the absence of a reading or the name of the height itself, the ground is called "nameless";

absolute altitude - the altitude of a point of the earth's surface above sea level (in the USSR, above the mean level of the Baltic Sea);

commanding height - an eminence (mountain, hill, mound, etc.) which is distinguished by its height and which predominates above the surrounding terrain; the altitude readings of commanding heights are written on the map in bolder letters;

relative altitude - the difference in height between two points (or surfaces). The relative altitude of a point is determined as the difference in the absolute altitudes of the points.

ВЫСОТА СЕЧЕНИЯ РЕЛЬЕФА
VYSOTA SECHENIYA REL'YEFA

Contour interval. The distance between two adjacent primary altitude contour lines. The contour intervals indicated in Table 1 have been adopted on Soviet topographic maps.

Table 1

Contour Intervals

1 Масштаб карты	2 Высота сечения, м			
	3 нормальная для равнинно-холмистой местности	4 для горной местности	5 для высокогорной местности	6 для плоско-равнинной местности
1:10 000	2,5	5,0	—	2,5
1:25 000	5,0	5,0	10,0	2,5
1:50 000	10,0	10,0	20,0	10,0
1:100 000	20,0	20,0	40,0	20,0
1:200 000	40,0 (20)	40,0	80,0	40,0
1:500 000	50,0	100,0	100,0	50,0

Key: 1 - map scales; 2 - contour interval, meters; 3 - normal for hilly-flat terrain; 4 - for mountain terrain; 5 - for high mountain terrain; 6 - for plane-flat terrain.

The contour interval on maps with a scale of 1:1,000,000 is established depending on the nature of the terrain. With absolute altitudes up to 400 meters, it is taken as 50 meters, from 400 to 1,000 meters, as 100 meters, from 1,000 to 2,000 meters, as 200 meters, and above 2,000 meters, as 250 meters.

ГАТЬ

GAT'

Causeway. A transverse decking of logs on roads which cross over swampy terrain sectors.

ГЕОГРАФИЧЕСКАЯ СЕТКА (картографическая сетка)
GEOGRAFICHESKAYA SETKA (kartograficheskaya setka)

Geographic grid (cartographic grid). The grid of parallels and meridians on maps.

ГЕОГРАФИЧЕСКИЕ КООРДИНАТЫ
GEOGRAFICHESKIYE KOORDINATY

Geographic coordinates. Angular values (latitude φ and longitude λ) which determine the position of a point on the earth's surface. The value φ is determined by the angle which is formed by the perpendicular line drawn through the given point and the plane of the equator. It is read (fig. 2) north from the equator from 0 to 90° (north latitude) and from the equator south from 0 to -90° (south latitude). The value λ is determined by the two-sides angle which is formed by the plane of the prime meridian and the plane of the meridian of the given point. Reading is conducted from the prime meridian to the east from 0 to 180° (east longitude) and to the west from 0 to -180° (west longitude).

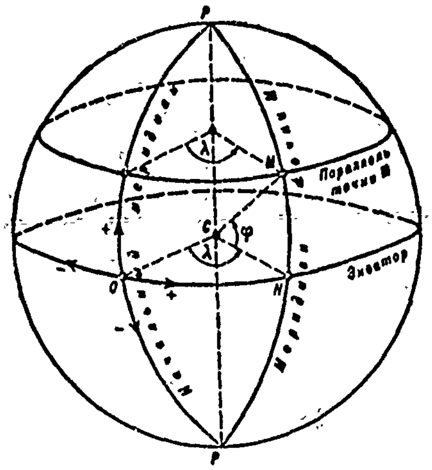


Figure 2. Geographic coordinates.

Left meridian - prime meridian; right meridian - meridian of point; upper parallel - parallel of point M; lower parallel - equator.

ГЕОДЕЗИЧЕСКАЯ ЗАДАЧА ОБРАТНАЯ
GEODEZICHESKAYA ZADACHA OBRATNAYA

Inverse geodetic problem (on a plane). Determination of Y-azimuth from one point to another and the distance between them from the rectangular coordinates of the initial points. The inverse geodetic problem is solved by the formulas

$$\operatorname{tg}\alpha = \frac{y_B - y_A}{x_B - x_A};$$

$$D = \frac{y_B - y_A}{\sin\alpha} = \frac{x_B - x_A}{\cos\alpha},$$

where

x_A, x_B, y_A, y_B are the coordinates of the initial points;

α is the Y-azimuth from point A to point B;

D is the distance between the initial points.

ГЕОДЕЗИЧЕСКАЯ ЗАДАЧА ПРЯМАЯ
GEODEZICHESKAYA ZADACHA PRYAMAYA

Direct geodetic problem (on a plane). Determination of the coordinates of required point B from known rectangular coordinates of initial point A, the distance between them, and the Y-azimuth of the line of direction from the initial point to the point being determined. The direct geodetic problem is solved from the formula

$$x_B = x_A + D \cdot \cos \alpha;$$
$$y_B = y_A + D \cdot \sin \alpha;$$

where

x_B, y_B are the coordinates of the point being determined;
x_A, y_A are the coordinates of the initial point;
D is the distance between the point being determined and the initial point;
α is the Y-azimuth of the line of direction from the initial point to the point being determined.

ГЕОДЕЗИЧЕСКАЯ ЛИНИЯ
GEODEZICHESKAYA LINIYA

Geodetic line. A line which connects two points on the terrestrial ellipsoid (see). It is the shortest distance between given points on the surface of the ellipsoid (the shortest distance on a plane is a straight line, on a sphere - an arc of the great circle).

ГЕОДЕЗИЧЕСКИЕ КООРДИНАТЫ
GEODEZICHESKIYE KOORDINATY

Geodetic coordinates. Values which determine the position of a point on the earth's surface on the terrestrial ellipsoid (see): B - latitude, L - longitude, H - distance from the surface of the terrestrial ellipsoid along the normal to it to the given point on the earth's surface. Geodetic coordinates are determined by computation from the measured distance and a line of direction from some other point with known astronomic coordinates and depend on the accepted dimensions of the terrestrial ellipsoid and the coordinates of the initial point. In the USSR, the center of the Round Chamber of the Pulkovskiy Astronomical Observatory is taken as the initial point with coordinates: 59°46'18.71"N, 30°19'38.55" E.

Geodetic latitude and longitude are similar to astronomical coordinates but their values differ somewhat due to the deviation of the perpendicular line (on the earth's sphere) from the normal of the terrestrial ellipsoid.

ГЕОДЕЗИЧЕСКИЙ ПУНКТ
GEODEZICHESKIY PUNKT

Geodetic point. A point which is firmly fastened on the terrain by an underground marker (monolith and others) and a surface structure in the form of a signal, pyramid, etc., the coordinates of which are determined with high accuracy in accordance with its order. Geodetic points are used in creating topographic maps, for the tie-in of elements of the combat formations of missiles and artillery, and for other precise measurements. The aggregate of geodetic points comprises the geodetic net. Coordinates of geodetic points are systematized in the form of catalogs which are published and issued to the troops.

ГЕОДЕЗИЯ
GEODEZIYA

Geodesy. A science, the subjects of which are determining the shape and dimensions of the earth; the portrayal of the earth's surface on planes and maps, and the conduct of precision measurements on the terrain in accomplishing various engineer and other measures.

Geodesy includes two basic disciplines, higher geodesy and topography. The main task of higher geodesy is the determination of the form and dimensions of the earth as a whole and the creation of a geodetic base for the study of the geometric qualities of the earth's surface. The main tasks of topography are the detailed study of the earth's surface and its portrayal on planes and maps as well as the performance of various measurements on the ground in accomplishing engineer, fire, and other missions.

ГЕОИД
GEOID

Geoid. The shape of the earth formed by the imaginary flat surface of the mean level of the ocean. In its shape, the geoid is close to an ellipsoid (a solid formed by the rotation of an ellipse around its smaller axis).

ГИРОКОМПАС
GIROKOMPAS

Gyrocompass. An instrument for orientation according to the directions of the compass which is not subject to the influence of the magnetic field. The action of the gyrocompass is based on the property of a freely suspended body which rapidly rotates around its axis (the gyroscope rotor) to counteract external influences and preserve its initial position; with the corresponding improved equipment of the gyrocompass, its rotor enters the plane of the geographic meridian, i.e., the plane of the earth's axis of rotation, and retains this position subsequently regardless of the turns of the object on which it is installed.

ГИРОПОЛУКОМПАС
GIROPOLUKOMPAS

Directional gyro. A navigational instrument intended for holding direction of movement under conditions of difficult orientation. The sensitive element of the directional gyro is served by a free gyroscope placed in a metal housing with a window (see fig. 73) in front of which a scale with divisions is fastened.

The course of the machine (direction of movement) is estimated from the mutual position of the scale (fastened on the axis of the gyroscope's Cardan suspension) and the index firmly connected with the instrument housing and, consequently, with the machine; when the machine turns, the reading on the scale changes by the angle of turn.

By means of the directional gyro, the machine's course of movement can be maintained with an accuracy on the order of 1 - 2° with a duration of continuous operation (without reorientation) of not more than 1.5 hours.

ГЛАВНАЯ ВЕРТИКАЛЬ
GLAVNAYA VERTIKAL'

Principal vertical. A line which passes through the principal point of an aerial photo (see) and the point of the nadir (point of intersection of a vertical line dropped from the center of the objective lens at the instant of photography with the plane of the photo).

ГЛАВНАЯ ГОРИЗОНТАЛЬ
GLAVNAYA GORIZONTAL

Principal horizontal. A line perpendicular to the principal vertical (see) and passing through the principal point of the aerial photo (see).

ГЛАВНАЯ ТОЧКА АЭРОСНИМКА
GLAVNAYA TOCHKA AEROSNIMKA

Principal point of an aerial photo. The base of a perpendicular dropped from the center of the objective lens to the photo. The principal point of an aerial photo is located in the center of the photo and is determined by the intersection of the corresponding tick marks or lines which connect the opposite coordinate marks.

ГЛАЗОМЕРНАЯ С"ЕМКА
GLAZOMERNAYA S"YEMKA

Sketching by eye. See Military sketching by eye [Voyenno-glazomernaya s"yemka].

ГЛУБИНА УКРЫТИЯ
GLUBINA UKRYTIYA

Depth of defilade. The vertical distance from a gun or other object to the ray of vision which goes from a known or probable enemy observation post across the apex of a covering barrier.

ГОРИЗОНТ
GORIZONT

Horizon. A portion of the earth's surface visible on open terrain when it is surveyed through 360°. The size (diameter) of the visible horizon is increased with an increase in the height of the observer's position. The term "horizon" is also given to a line along which the sky seems to merge with the earth.

ГОРИЗОНТАЛЬ
GORIZONTAL'

Contour line. A line which connects points of relief with the same altitude above sea level on a map. On Soviet topographic maps, the following contour lines are distinguished:

main heavy contour lines (each fifth main contour line) - for convenience in determining the relief, it is distinguished by increased thickness;

main contour lines which correspond to the contour interval (see contour inverval [vysota secheniya rel'yefa]) - depicted on a map by a continuous heavy line;

additional (half-contour) lines - shown as a thin broken line every 0.5 contour interval;

auxiliary contour lines - shown as short sections of a broken curve at an arbitrary height (for example, every 0.25 contour interval).

ГОРИЗОНТАЛЬНАЯ ПРОЕКЦИЯ
GORIZONTAL'NAYA PROYEKTSIYA

Horizontal (orthogonal) projection. A method of projecting (transferring) points, lines and objects on a horizontal plane with straight lines perpendicular to it (fig. 3), where D is a line projected to the horizontal plane P; Aa and Bb are lines perpendicular to the plane P; d is the horizontal projection of the line D; α is the angle of incline of the straight line to the horizontal plane.

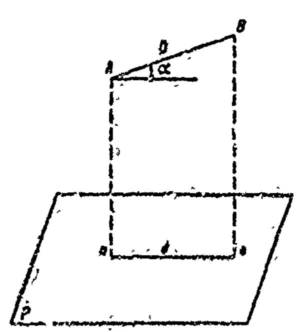


Figure 3. Horizontal projection.

The horizontal projections of points, lines, and terrain contours are depicted on a map (plan). The horizontal projections are always shorter than the sloping lines (Table 2).

Table 2

Reduction in the lengths of sloping lines on maps.

1 Угол наклона, градусы	2 Уменьшение длины линии на карте, %
5	0,4
10	1,5
15	3,5
20	6,4
30	15,5

Key: 1 - Angle of slope, degrees; 2 - reduction in length of line on map, %.

ГОРИЗОНТАЛЬНОЕ ПРОЛОЖЕНИЕ
GORIZONTAL'NOYE PROLOZHENIYE

Horizontal projection. See horizontal projection [gorizontal'naya proyektsiya].

ГОСУДАРСТВЕННАЯ ГЕОДЕЗИЧЕСКАЯ СЕТЬ
GOSUDARSTVENNAYA GEODEZICHESKAYA SET'

State geodetic net. The aggregate of geodetic points (see) disposed on a certain order on the territory of a country (usually in the form of triangles). The state geodetic net is divided into classes depending on the distance between the geodetic points and the precision of their determination; first-order points are determined most precisely.

ГРАВИМЕТРИЧЕСКИЕ ДАННЫЕ
GRAVIMETRICHESKIYE DANNYYE

Gravimetric data. Values which characterize the earth's gravitational field; they are used in calculations of flight trajectories of rockets which are launched over great distances (see gravimetry [gravimetriya], gravimetric charts [gravimetricheskiye karty]).

ГРАВИМЕТРИЧЕСКИЕ КАРТЫ
GRAVIMETRICHESKIYE KARTY

Gravimetric charts. Special charts on which data on the values of gravitational anomalies are given. Gravimetric charts are prepared on the territory of dry land, as well as on expanses of water. The basis of gravimetric charts is provided by general geographic (topographic) maps on which lines of the same gravity anomalies are plotted. These lines are called isoanomalies. The isoanomaly interval may vary; on a gravimetric chart with a scale of 1:1,000,000 the isoanomalies are drawn every 2 mlg (milligal [see gravimetry]). Gravimetric charts are intended primarily for the

determination of gravimetric data necessary for the calculation of trajectories of artificial satellites and rockets with a great range of flight (see gravimetry [gravimetriya]).

ГРАВИМЕТРИЯ
GRAVIMETRIYA

Gravimetry. The science of measurement of values which characterize the earth's magnetic field. Gravity on the earth is the resultant of two forces, the attractive force of a given body and the centrifugal force which arises as a result of the earth's rotation. The centrifugal force achieves its maximum at the earth's equator, but even here it comprises only 1/288 of gravity. On the surface of the earth, gravity depends primarily on the distribution of density within the earth and on the shape and dimensions of the earth's surface.

The basic physical value which is studied in gravimetry is the acceleration of gravity (designated by the letter g). The gal serves as the unit of measurement of g: 1 gal = 1 cm/sec^2; one thousandths of this value is called the milligal (1 mlg). On the earth's surface, g changes approximately from 978 to 983 gals, increasing from the equator toward the poles and decreasing with an increase in altitude.

Gravity is determined by means of special instruments - gravimeters, which permit determining acceleration with an accuracy of up to 0.3 - 0.4 mlg. The difference between the actually determined gravity reduced to sea level and the theoretical value is called a gravitational anomaly. The values of the gravitational anomalies are used in calculations of the trajectories of artificial satellites and long-range missiles. From the values of the gravitational anomalies, one can find the deviation of a perpendicular line at a given point on the earth's surface from the normal to the surface of an ellipsoid. The size of this deviation is used in changing from astronomic coordinates to geodetic coordinates (see gravimetric charts [gravimetricheskiye karty]).

ГРАД
GRAD

Grad. A unit of the decimal system of angular measurements which equals 0.01 straight angle of 0.9 degree. The grad is divided into 100 metric minutes; each metric minutes is divided into 100 metric seconds.

ГРЕБЕНЬ
GREBEN'

Crest. The upper portion of a ridge which contains the watershed line (see). Topographic crests and military crests (see) are distinguished.

ГРУНТОВЫЕ ДОРОГИ
GRUNTOVYYE DOROGY

Dirt roads. Vehicular and horse-drawn transport roads with a natural base and surface: improved dirt roads, dirt (country), field, and forest roads.

ГРЯДОВЫЕ ПЕСКИ
GRYADOVYYE PESKI

Ridgy sands. The sandy surface of a desert in the form of a ridge up to 20 to 30 meters high with a steepness of slope of up to 20° extending along the direction of the prevailing winds. Ridgy sands are usually covered with sparse vegetation and are relatively easy to cross, particularly along the ridge.

ДЕЛЕНИЕ УГЛОМЕРА (тысячная)
DELENIYE UGLOMERA (tysyachnaya)

Mil. The central angle subtended by an arc which equals 1/6000th of the length of an entire circle. The length of the arc of an angle of one mil is approximately equal to 0.001 radius (range). One hundred mils, sometimes called small mils, make one large mil. An example of the recording and reading: 4-36 is four thirty-six which means 436 small mils or 4 large mils and 36 small mils. (For the conversion of mils to degrees, see Section 4, Chapter XII).

ДЕМАСКИРУЮЩИЕ ПРИЗНАКИ
DEMASKIRUYUSHCHIYE PRIZNAKI

Revealing signs. The aggregate of signs from which it is possible to identify various objects on aerial photos. The following basic revealing signs are distinguished: shape, dimension, tone (degree of darkening of the emulsion), shadow, mutual disposition, traces of troops activity (for greater detail, see Section 8, Chapter IV).

The term "revealing sign" is also used in a wider sense - as the indications and information from which data on the enemy's situation and intentions are disclosed.

ДЕФИЛЕ
DEFILE

Defile. A narrow passage between obstacles (abrupt folds in the relief, swamps, lakes, etc.) which is usually used to stop the enemy by the defending troops.

ДЕШИФРИРОВАНИЕ АЭРОСНИМКОВ
DESHIFRIROVANIYE AEROSNIMKOV

Aerial photo interpretation. Determination of quantitative and qualitative characteristics of the terrain and enemy from aerial photos (for greater detail, see Section 8, Chapter IV).

ДИРЕКЦИОННЫЙ УГОЛ
DIREKTSIONNYY UGOL

Grid azimuth. The angle between the northern direction of the vertical line of a coordinate grid and the line of direction to an object, read in a clockwise direction from 0 to 360°.

ДОЛГОТА ГЕОГРАФИЧЕСКАЯ
DOLGOTA GEOGRAFICHESKAYA

Geographic longitude. See geographic coordinates [geograficheskiye koordinaty].

ДОЛИНА
DOLINA

Valley. Elongated, usually winding, negative form of relief which lowers in one direction and is formed by two slopes, the intersection of which represents a thalweg - the lower zone of the valley bottom, usually occupied by a channel of a permanent or intermittent runoff. Valleys with vertical slopes are called canyons and if, in addition, they are very narrow, they are called gorges or notches. Comparatively small valleys devoid of permanent runoffs are called hollows.

ДОПОЛНИТЕЛЬНАЯ СЕТКА НА КАРТАХ
DOPOLNITEL'NAYA SETKA NA KARTAKH

Additional grid on maps. Coordinate grid in the system of an adjacent zone. It is plotted on a map with special tick marks on sheets located along the border of each zone (for greater detail, see Section 7, Chapter III).

ДОРОГИ
DOROGY

Roads. More or less improved routes intended for constant or prolonged movement over them. The following roads are distinguished: railroads [zheleznyye] (see), vehicular and horse-drawn transport roads [avtoguzhevyye dorogy] (see), and paths [tropy] (see). The most important roads which connect countries, oblast', industrial areas, large centers, etc., are called main lines.

With respect to the relative disposition (actions) of the troops, the following are distinguished: frontal roads which go from the rear toward the front, and lateral roads which go approximately parallel to the front line.

ДЮНЫ
DYUNY

Dunes. Sand hills with a crescent-like shape in a plane which is formed under the influence of the wind from unfixed sands. The height of dunes reaches 300 meters. In contrast to barkhans, the "horns" of the ends are directed against the wind. The slow movements of the dunes are possible under the influence of the wind. Dunes are negotiable with difficulty.

ЕСТЕСТВЕННЫЕ МАСКИ
YESTESTVENYYE MASKI

Natural masks. Elements of the terrain which contribute to the camouflage of troops against enemy observation from the air and ground observation posts.

Natural masks are: elements of the relief (gullies, precipices, and other uneven terrain); vegetation (forests, brush, high grass, gardens, and others); structures of all types, fences, ditches, haystacks, ricks, and other local objects.

ЕСТЕСТВЕННЫЕ ПРЕПЯТСТВИЯ
YESTESTVENNYYE PREPYATSTVIYA

Natural obstacles. Local objects and elements of relief which cause the delay or stopping of the movement of troops and thereby hinder their combat actions. Most widespread are: rivers, ditches, lakes, muddy swamps, steep slopes, precipices, gullies, dense woods, buildings and various structures, embankments, depressions, etc.

ЕСТЕСТВЕННЫЕ УКРЫТИЯ
YESTESTVENNYYE UKRYTIYA

Natural cover. Local objects and elements of the relief which favor the cover (protection) of the troops and equipment against enemy fire and observation. As natural cover, use is made most often of ditches, pits, depressions, gullies, wash-outs, precipices, embankments, basements, caves, various strong structures (stone, brick, ferroconcrete), etc.

ЖЕЛЕЗНЫЕ ДОРОГИ
ZHELEZNYYE DOROGI

Railroads. Roads of rails on a m· ı ż or less substantial foundation. Railroads are differentiated: by width of track - wide gauge (normal) and narrow gauge, by means of locomotion - electrified and non-electrified; by number of tracks - single-tracked, double-tracked, and with a larger number of tracks. The width of track of Soviet railroads is 1524 mm and of narrow gauge tracks, 750, 900, and 1000 mm. The most widespread width of track of foreign railroads is 1435 mm (up to 65% of the railroads).

ЗАЛОЖЕНИЕ СКАТА
ZALOZHENIYE SKATA

Horizontal projection of the slope. See Slope [skat].

ЗАМЕТКИ
ZAMETKI

Sketch notes. A graphic representation of characteristic points and lines of the relief (fig. 4): divide - a continuous line with an arrow in the direction of the drop of the ridge; runoff - a broken line with an arrow in the direction of drop of the depression; summit - a closed contour line which gives its outline in a plane, with indicators of the slope; saddle - a dotted figure which gives the plane outline of the saddle. Sketch notes are used for the rapid sketching of characteristic forms of relief from the actual ground or from a map in preparing terrain sketches by eye.

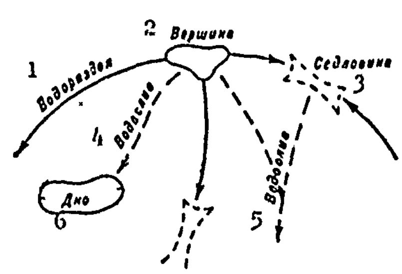


Figure 4. Sketch notes.
1 - divide; 2 - summit; 3 - saddle; 4 - runoff;
5 - runoff; 6 - bottom.

ЗАСЕЧКА
ZASECHKA

Intersection. A method of determining the position of a station or object (target, reference point) on a map by the intersection of two or more lines;

the point of intersection of the lines corresponds to the position of the object (station);

direct intersection - the position of an object is determined by the intersection of two lines which are formed by direct sighting on the object from two stations, the positions of which are known on a map;

resection - the position of a station is determined by the intersection of lines obtained by the reverse sighting "on one's self" at three (at two if the map is oriented) reference points, the positions of which are known on the map;

combined intersection - the position of an object is determined by the intersection of two lines of direction which are formed by direct sighting from a reference point to the object and reverse sighting from the object to another reference point (the positions of the reference points should be known on the map);

compass intersection - the position of a station or object is determined by direct intersection, resection, or combined intersection with the use of a compass, by measuring the azimuths of the required lines of direction and their subsequent construction on the map from Y-azimuths.

ЗАЩИТНЫЕ СВОЙСТВА МЕСТНОСТИ
ZASHCHITNYYE SVOYSTVA MESTNOSTI

Protective properties of the terrain. The aggregate of natural cover which reduces the injury to personnel and equipment by nuclear weapons and which is used in organizing the protection of troops against weapons of mass destruction. The best protective properties are possessed by abrupt and deep folds in the relief (gullies, wash-outs, depressions, gorges), quarries, shafts, mines, caves, caverns, forests (for greater detail, see Section 5, Chapter V).

ЗВЕЗДНАЯ КАРТА
ZVEZDNAYA KARTA

Star chart. A representation of a portion of the celestial sphere on a plane. A star chart is used in military affairs primarily to find individual stars in solving problems in astronomic orientation.

ЗЕМНОЙ МАГНЕТИЗМ
ZEMNOY MAGNETIZM

Terrestrial magnetism. A property of the earth as a heavenly body which is expressed by the existence of a magnetic field around it. The poles of terrestrial magnetism are close to the geographic poles but do not coincide with them (the north pole, 74°N, 100°W, the south pole 69°S, 144°E). A freely turning needle of a magnetic compass is placed in the plane of the magnetic

meridian. On approaching the poles, the magnetic needle has a tendency to change from a horizontal (equilibrium) position to a vertical position. This phenomenon is called the magnetic dip. Its effect on the operation of the compass is eliminated by shifting a special weight on the needle.

ЗЕМНОЙ ЭЛЛИПСОИД (сфероид)
ZEMNOY ELLIPSOID (sferoid)

Earth's ellipsoid (spheroid). The shape of the earth which is taken for cartographic and other purposes as the initial shape for computations (fig. 5). The dimensions of the earth's ellipsoid are indicated in Table 4.

Figure 5. Earth's ellipsoid.

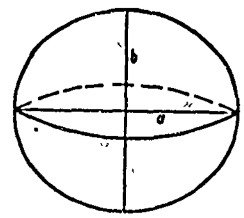


Table 4

Dimensions of the earth's ellipsoid (according to F.P. Krasovskiy)

Elements	Size
Large semiaxis (equatorial radius) a	6,378,245 meters
Small semiaxis (polar radius) b	6,356,863 meters
Compression = a-b/a	1:298.3
Average radius of the earth, taken as a sphere	6,371,117.7 meters
Length of meridian	40,008,548 meters
Length of equator	40,075,704 meters
Surface of the earth	510,083,000 sq km
Surface of dry land	148,628,000 sq km (29.2%)
Surface of water	361,455,000 sq km (70.8%)
Volume of earth	1,083,320,000,000 km^3

ЗИМНЯЯ ДОРОГА
ZIMNYAYA DOROGA

Winter road. A seasonal vehicular and horse-drawn transport road over frozen swamps, lakes, and rivers.

ИЗОБАРЫ
IZOBARY

Isobars. Lines which connect on a chart (diagram) points with the same barometric pressure at a certain time.

ИЗОБАТЫ
IZOBATY

Isobaths. Lines which connect on a chart points with equal depths or relief of the sea bottom or other body of water.

ИЗОГИПСЫ
IZOGIPSY

Isohypses (contour lines). Lines which connect on a chart points with the same altitude above sea level.

ИЗОЛИНИИ
ISOLINII

Isolines. Lines which connect on charts and special diagrams points with the same values of some factor (altitudes, temperatures, etc.).

ИЗОТЕРМЫ
IZOTERMY

Isotherms. Lines which connect on a chart (diagram) points of equal temperature.

ИСТОЧНИКИ
ISTOCHNIKI

Sources (springs, fountains). Natural outcroppings of underground water on the earth's surface. The majority of sources are shown on large-scale and medium-scale topographic maps; the inscription which accompanies the conventional sign (rod., kl., ist) expresses the designation accepted in a given area.

ИСХОДНЫЕ ГЕОДЕЗИЧЕСКИЕ ДАННЫЕ
ISKHODNYYE GEODEZICHESKIYE DANNYYE

Initial geodetic data. Geodetic and topographic values which are necessary for the launching of rockets. The primary ones are:

geodetic launch range, the length of the geodetic line (see) from the launching position to the target;

geodetic Y-azimuth of the launching position - target line of direction;

altitude of the locations of the launch position and the target (determined from a topographic map);

geodetic azimuth of the line of direction to the target (determined from the geodetic Y-azimuth);

geodetic latitude of the launch position (determined from a topographic map).

The geodetic range and geodetic Y-azimuth are determined from the coordinates of the launch position and those of the target by solving the geodetic resection problem.

КАРАВАННЫЙ ПУТЬ
KARAVANNYY PUT'

Caravan routes. A transportation route for pack animals (camels, asses, mules, less often horses) in desert and semidesert terrain. Caravan routes are shown on topographic maps.

КАРТОГРАФИЧЕСКИЕ ПРОЕКЦИИ
KARTOGRAFICHESKIYE PROYEKTSII

Cartographic projections. Methods of representing the surface of the earth's sphere on a plane in compiling maps. The cartographic projection determines the mathematical law for projecting the earth's surface on a plane and characterizes distortions of lengths, angles, and areas on a given map since a spherical surface is not spread into a plane without distortion.

In accordance with the nature of the distortions, the following cartographic projections are distinguished: equiangular, which preserve the equality of angles between lines of direction on a map and in actuality; equidimensional, which preserve the proportionality of areas on the map to the corresponding areas on the earth's surface; equiinterstitial, which preserve the constancy of scale in some direction; arbitrary, which do not preserve either the equality of angles, proportionality of area, or constancy of scale. The concept of employing arbitrary projections consists of the simplicity of compiling maps, the convenience of solving several practical problems on such a map, etc.

Cartographic projections are also divided according to the type of geographic grid. The basic ones are conical, cylindrical, azimuty, and pseudocylindrical.

In a conical projection, the meridians are represented by straight lines which converge at one point at equal angles; parallels are represented by concentric circles with a common center at the point of intersection of the meridians. Many small-scale maps of the Soviet Union and other areas of the world are prepared in a conical projection.

In a cylindrical projection, the meridians are represented by parallel straight lines; the parallels are also represented by straight parallel lines which are perpendicular to the meridians. Political maps of the world, maps of equatorial countries, and several other maps are compiled in a cylindrical projection.

In an azimuth projection, the meridians are represented by straight lines which converge at one point at angles which equal the difference in longitudes while the parallels represent arcs of concentric circles. Maps of the Arctic and Antarctic, maps of the hemisphere, and others are prepared in an azimuth projection.

In a pseudocylindrical projection, some central meridian is represented by a straight line, and the remaining meridians, by curves symmetrical to the central meridian. Individual political maps of the world are compiled in this projection.

The cartographic projection of topographic maps of the Soviet Union at a scale of 1:25,000 - 1:500,000 are equiangular transverse-cylindrical. Its essence consists of the following. The surface of the earth's spheroid is divided into zones by meridians which are multiples of 6°, beginning with the zero (greenwich) meridian. Within the limits of each zone, the surface of the earth's spheroid is projected onto a plane with preservation of the similarity of infinitely small shapes. The lengths of lines are preserved only along the principal meridian; in the other places, they are exaggerated somewhat and the further from the principal meridian, the greater the degree. The maximum error in the lengths of lines on the map which are adjacent to the boundary of the zone does not exceed 1/1000, i.e., considerably less than the graphical precision of measurement. All sheets of topographic maps within the limits of a zone may be glued together into one block without any gaps or folds. Map sheets of adjacent zones may be glued together in limited numbers.

The cartographic projection of a map at a scale of 1:1,000,000 is arbitrary. The extreme parallels of the map sheet are arcs of circles, the lengths of which are not distorted; all meridians are straight-line; meridians disposed symmetrically relative to the central meridian 2° to the west and east preserve their length; the length of the central meridian is shortened somewhat. No more than 9 sheets can be glued into one block without noticeable gaps.

КАРТОГРАФИЯ
KARTOGRAFIYA

Cartography. The science of geographic maps, methods, and processes for their creation and use. It includes the disciplines: mathematical cartography, map compilation, map publication, and map measurement.

КАРТОЧКИ (СХЕМЫ) МЕСТНОСТИ
KARTOCHKI (SKHEMY) MESTNOSTI

Torrain cards (sketches). Simple, schematic drawings of small sectors of terrain made without precise observation of scale. The cards are used primarily by commanders of small podrazdeleniye in the form of a "sketch of a strong point," "sketch of reference points," or in the form of a sketch report, a drawing on which the results of reconnaissance of the enemy and terrain or the accomplishment of some other mission are depicted graphically and with text.

КАРТЫ
KARTY

Maps. Reduced conventional representations of the earth's surface on a plane which is made in the form of some kind of cartographic projection (see). Maps are extremely varied and subdivided according to many criteria. For content, maps are divided into general geographic maps (see) and special maps (see).

КАРТЫ ВОДНЫХ РУБЕЖЕЙ
KARTY VODNYKH RUBEZHEY

Water area charts. Special maps intended for the study and evaluation of water areas; the scale is primarily 1:100,000 to 1:50,000; sometimes the scale of the representation of a river is greater than the scale of the representation of the adjacent terrain. Basic content: width, depth, direction, and speed of current of a river, type of bottom, nature of the banks, river channel, and command of the banks of the river valley; the detailed characteristics of existing crossings (sometimes given in the legend), bridges, ferries, fords; the characteristics of hydraulic works, hydroelectric stations, particularly their dams and locks, etc.; boundaries of inundation of the floodplain and its trafficability: swampiness, degree to which broken up by lakes, ox-bow lakes and channels, the ground, vegetational cover, road net, etc.

КАРТЫ ГЕОЛОГИЧЕСКИЕ
KARTY GEOLOGICHESKIYE

Geological maps. Special maps which represent the regularities of the structure of the earth's crust and are the basis for the search for minerals, explorations, for the construction of various objects, soil, botanical and other investigations. Geological maps are subdivided into survey maps (1:2,500,000 - 1:5,000,000), regional maps (1:200,000) and detailed maps (1:100,000 - 1:50,000 or larger, down to 1:50). In military affairs, the latter are used most widely and more or less characterize the outcroppings of rock on the surface.

КАРТЫ ДОРОЖНЫЕ
KARTY DOROZHNYYE

Road maps. Special maps which are used in planning, organizing, and executing shipments and working out measures for the organization of the troop rear; most often, the scale is 1:1,000,000 or 1:500,000. Special content of the maps: motor vehicle roads and railroads; characteristics of the quality and traffic capacity of motor vehicle roads: class, width, surface of the roadway; characteristics of bridges; road structures; distance between populated places and other points recorded on the map.

КАРТЫ ЛОЦМАНСКИЕ
KARTY LOTSMANSKIYE

Pilot charts. Charts intended for the navigation of vessels and the planning of hydraulic works on rivers. Scales of charts and the isobath interval are indicated in Table 5.

Table 5

Scales of pilot charts and isobath intervals.

Average width of river, meters	Map scales	Isobath interval, meters
Up to 150	1:5,000	0.25 - 0.50
150 - 250	1:10,000	0.5 - 1.0
250 - 500	1:10,000-1:25,000	0.5 - 1.0
500 - 2,000	1:25,000-1:50,000	1.0 - 2.0

Pilot charts contain detailed (systematically updated) information on the coastline, depths, underwater obstacles, and navigational markers. Depths are shown by isobaths and depth readings; the depth is read from the level at the low water mark [mezhen] (see). To obtain the actual depth of a level, it is necessary to consider the difference in the level of the river which was taken in compiling the map and the level at a given moment. On pilot charts, the shores are shown schematically, as a rule. Pilot charts are used together with river sailing directions (see) [lotsiya reki].

КАРТЫ МОРСКИЕ
KARTY MORSKIE

Sea charts. Special charts of the seas and oceans. The most important and widespread are navigational sea charts which are intended for the navigation of vessels. Their content: relief of the bottom, portrayed by isobaths and depth readings; characteristics of the ground; outline and characteristics of the shores, relief, and prominent reference points on shore; sea routes, navigational dangers (shoals, reefs, rocks, surfs); information on the magnetic declination; hydrological elements (currents, tides, boundaries of ice). Navigational charts include plans (larger than 1:25,000), individual charts (1:25,000 - 1:100,000), route maps (1:100,000 - 1:500,000), and general and survey charts (1:500,000 and smaller). The contents of navigational charts are supplemented and explained by sailing directions (see).

КАРТЫ ОБЩЕГЕОГРАФИЧЕСКИЕ
KARTY OBSHCHEGEOGRAFICHESKIYE

General geographic maps. Maps reflecting the relief, hydrography, and, partially, elements of the soil-ground and vegetational cover, roads, populated places, socio-economic objects, and several other elements. General geographic maps are subdivided into topographic maps - up to 1:1,000,000 inclusive and survey general geographic maps, scale smaller than 1:1,000,000.

КАРТЫ ПРОХОДИМОСТИ
KARTY PROKHODIMOSTI

Trafficability maps. Special maps with data on terrain trafficability which are intended for the study and estimate of conditions for movement and maneuver. As a rule, they are compiled on the basis of topographic maps. Shown on the maps are sectors which are difficult and impossible to negotiate, the most favorable directions for movement, characteristics of relief (steepness and length of slopes, precipices, and their heights, gullies, wash-outs), and rivers (depth, soil of bottom, speed of current, tidal zone, the presence of hydraulic works, crossings), roads ground-soil, and all other terrain elements which determine its trafficability.

КАРТЫ РЕЛЬЕФНЫЕ
KARTY REL'YEFNYYE

Relief maps. Maps which express the terrain relief volumetrically. They are made of a plastic base [viniprozy], cardboard, paper-mâché, or other material. Data on the content and preparation of a topographic map of corresponding scale are drawn (printed or pasted) on the surface of the relief map.

Relief maps are made either manually by the successive accretion of layers with the subsequent pasting of a model of the map, or on a special outfit which permits reproducing relief maps in the required numbers by means of a punch die which is made (set up) ahead of time.

Relief maps are intended for the study and estimate of the terrain and for gaming planned battles and operations. The maps are made in scales from 1:50,000 to 1:1,000,000. The vertical scale depends on the nature of the relief of the terrain but is always greater than the horizontal scale; for flat terrain, 25 - 10 times, for hilly terrain, 10 - 5 times, for mountain terrain, 5 - 2 times.

КАРТЫ СПЕЦИАЛЬНЫЕ
KARTY SPETSIAL'NYYE

Special maps. Maps on which individual elements of the terrain are represented with great completeness and detail or on which special data are plotted. Special maps are extremely numerous and varied. They include the following maps: geological, soils, hypsometric, hydrological, political-administrative, economic, and many others. The most important special maps which are used by the troops are navigational, road, and relief maps.

КАРТЫ ТОПОГРАФИЧЕСКИЕ
KARTY TOPOGRAFICHESKIYE

Topographic maps. General geographic maps up to a scale of 1:1,000,000 inclusive. Topographic maps represent as completely as possible the elements and details of the terrain which affect the combat actions of troops and are the basic source of information about the terrain and the basis of many combat documents and special maps. In preparing and conducting combat actions, topographic maps are used to study the terrain, clarify missions, estimate the situation, make decisions, assign missions to subordinate troops, and organize troops coordination, and also are widely used for orientation on the ground (primarily maps at a scale of 1:50,000-1:200,000), determining target coordinates (primarily maps with scales of 1:50,000-1:100,000), and for tying in the combat formations of the troops (primarily maps of scales of 1:50,000-1:200,000). A list of topographic maps is shown in Table 6.

The completeness and detail of representation of the terrain on topographic maps depend on their scale (the larger the scale, the more complete and detailed the map) and the nature of the terrain (the fewer details the terrain contains, the more completely they are shown on the map). The completeness of content of maps of average broken terrain are characterized approximately by the following data:

populated points are shown completely on large-scale maps; on maps of a scale of 1:100,000, individual yards and structures are shown partially; on maps at a scale of 1:200,000 and smaller, populated points are partially shown;

vehicular and horse-drawn transport roads are shown completely on large-scale maps; on maps of a scale of 1:100,000 and 1:200,000, all highways and improved dirt roads are shown while dirt and field roads are partially shown; all highways are shown on maps with a scale of 1:500,000 and dirt roads are shown partially; only main roads are shown on maps with a scale of 1:1,000,000,

all rivers are shown on maps at a scale of 1:25,000 - 1:100,000; on maps at a scale of 1:200,000 or smaller, rivers longer than 0.5 to 1 cm at the map scale are shown;

elements of relief (altitude, etc.) are represented with their height dimensions more than 0.5 the contour interval (see) of the given map (see accuracy of topographic maps [tochnost' topograficheskikh kart].

Table 6

List of topographic maps

Scale of maps	Name of maps	Approximate dimensions of sector covered by map sheet at 54° latitude	
		on terrain km	at map scale cm
	Large scale		
1:25,000 (1 cm = 250 m)	twenty-five thousand	9 x 8	36 x 32
1:50,000 (1 cm = 500 m)	fifty thousand	19 x 16	37 x 32
	Medium scale		
1:100,000 (1 cm = 1 km)	Hundred thousand or kilometer	37 x 32	37 x 32
1:200,000 (1 cm = 2 km)	Two hundred thousand, or 2 kilometers	74 x 65	37 x 33
	Small scale		
1:500,000 (1 cm = 5 km)	Five hundred thousand, or 5 kilometers	222 x196	44 x 37
1:1,000,000 (1 cm = 10 km)	Million, or ten kilometers	445 x393	44 x 39

Remarks: The first number in the column "at map scale" is the length of the sector from north to south, the second number is the size of the sector from east to west.

КАТАЛОГ КООРДИНАТ ГЕОДЕЗИЧЕСКИХ ПУНКТОВ
KATALOG KOORDINAT GEODEZICHESKIKH PUNKTOV

Geodetic trig list. Systematized data on geodetic points. The list is published in the form of pamphlets with a diagram of the mutual disposition of the points and includes: name of points, order of points, rectangular coordinate, absolute altitudes, altitude of markers, Y-azimuths of lines of directions to other points or specially established reference points.

КИЛОМЕТРОВЫЕ ЛИНИИ
KILOMETROVYYE LINII

Kilometer lines. Horizontal and vertical lines on topographic maps which are drawn parallel to the axes of rectangular coordinates at equal intervals. The aggregate of these lines forms a kilometer (coordinate) grid which is used in target indication from a map, orientation of the map on the ground, and for the approximate determination of distances and areas (Table 7).

Table 7
Distance between kilometer lines on maps

1 Масштаб карты	2 Расстояние	
	3 на карте, см	4 на местности, км
1: 10 000	10	1
1: 25 000	4	1
1: 50 000	2	1
1: 100 000	2	2
1: 200 000	2	4

Key: 1 - Map scales; 2 - distance; 3 - on map, cm; 4 - on terrain, km.

Kilometer lines are not drawn on maps with scales of 1:500,000 and 1:1,000,000 but on maps with a scale of 1:500,000, on the borders, tick marks are shown every 2 cm (10 km) and, when necessary, a kilometer grid may be drawn on the map.

Kilometer lines on maps are marked as follows: the values at the horizontal lines show the distance from the equator in kilometers to the given line; the values at the vertical lines signify the number of the zone (one or two digits) and the distance in kilometers (always three digits) from the principal meridian of the zone shifted arbitrarily to the west 500 km. The extreme kilometer lines on the map sheet are fully marked while the remainder are abbreviated with two digits (tens and units of kilometers).

КОДИРОВАННАЯ КАРТА
KODIROVANNAYA KARTA

Coded map. A special map for the secret control of troops. It represents a regular topographic map with printed code designations or coded numbers for objects and terrain sectors.

КОЛОННЫЙ ПУТЬ
KOLONNYY PUT'

Hasty road, trail. A direction for the temporary movement of troops which has been selected and marked out on the terrain. The hasty road is laid out in the absence of roads or for the purpose of concealing the maneuver of troops and is usually improved as follows: the roadway is cleared, runoffs and simple crossings over streams and other obstacles are built, etc.

КОМПАС
KOMPAS

Compass. An instrument for orientation according to directions on the horizon. In accordance with the principle of operation, compasses are subdivided into magnetic, mechanical (gyroscopic), and solar (for use in the polar regions). Among the ground forces, the most widespread field compasses are the magnetic compass of the Adrianov system, and the AK artillery compass.

The Adrianov compass (fig. 6) consists of a housing with an axis fastened to it, a magnetic needle, bearing circle (round plate with angular divisions), braking lever, and rotating lid with a sighting device. The value of a division of the primary (inner) scale of the bearing circle equals 3°; the rading of the divisions is performed in a clockwise manner; the directions 0°, 90°, 180° and 270° are marked with markers which glow in the dark. The outer scale of the bearing circle is in mils which increase counterclockwise; values are given every 500 mils.

Figure 6. Compass of the Adrianov system.

The accuracy in reading azimuth using the compass is on the order of 1 to 0.5 mils.

The AK artillery compass (fig. 7) consists of the same basic parts as the Adrianov system but, thanks to some improvements, is more convenient to use. With this compass, a lid with a mirrored interior surface provides the opportunity for the simultaneous orientation of the compass and sighting on an object. The bearing circle rotates, which permits bringing the zero (north) reading of the bearing circle under the north end of the needle at the instant of sighting. The needle fixes the north-south direction more rapidly and steadily; the braking of the needle is accomplished automatically when closing the lid. The divisions of the bearing circle are drawn every 100 mils and are read in a clockwise direction.

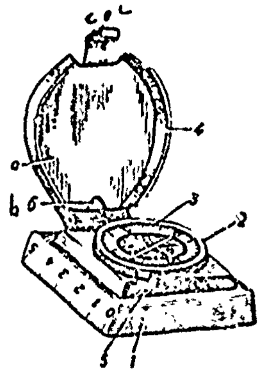


Figure 7. Compass of the AK system.

1 - compass housing; 2 - rotating housing of the bearing circle; 3 - bearing circle; 4 - compass lid with mirror a, with opening for sighting b, and catch c; 5 - projection of the needle braking lever.

КОНТУР
KONTUR

Outline. The boundary of lands or the external outline of a local object (outline of a meadow, outline of a swamp, etc.); it is shown on a map by a dotted or continuous line.

КОНТУРНАЯ ТОЧКА
KONTURNAYA TOCHKA

Map point. A clearly distinguishable point on the ground (corner of a woods, pasture, meadow, etc.). Map points which are easily noticeable on the ground are shown as accurately as possible on the maps and are often used for tying-in combat formations, determining the locations of stations, the positions of targets, and positions of other objects.

КООРДИНАТОМЕР
KOORDINATOMER

Coordinate scale. An instrument (device) for determining the rectangular coordinates of points (objects) from topographic maps and plotting points on a map from given coordinates. There are coordinate scales (engraved) on officer's celluloid scales. (For the use of coordinate scales, see Section 5, Chapter III).

КООРДИНАТЫ
KOORDINATY

Coordinates. Values which determine the position of a point on a plane or in space. In military affairs, the most widely used are astronomic (see), geographic (see), geodetic (see), rectangular (see), polar (see), and bipolar coordinates (see).

КОРЕННОЙ БЕРЕГ РЕКИ
KORENNOY BEREG REKI

Original river bank. The bank of a river valley, usually more or less expressed in the form of an escarpment or precipice, and composed of bedrock rather than from river deposits.

КОТЛОВИНА
KOTLOVINA

Basin.

A relief form, a closed depression (most often patelloid), deprived of external runoff.

КРОКИ
KROKI

Sketch. A sketch of the terrain made by hasty sketching which reflects in detail terrain elements, which are important for the accomplishment of a given specific mission. The base for the sketch may be prepared ahead of time from a map or aerial photo.

КУРВИМЕТР
KURVIMETR

Map measurer. An instrument for measuring distances on a map (see fig. 31). The measurement of lengths by a map measurer is performed by rolling the small wheel of the instrument along a line. The error in measuring the lengths of straight lines with the map measurer is on the order of 1 - 2% while the error in measuring the lengths of winding lines is considerably greater.

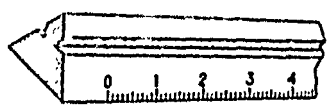
КЯРИЗЫ
KYARIZY

Near-horizontal underground water-collecting gallery. Water-collecting pits in arid areas which are connected with each other by underground galleries.

ЛИНЕЙКА ВИЗИРНАЯ
LINEYKA VIZIRNAYA

Sight rule. A rule (usually wooden, about 30 cm long) with a three-sides cross section; it is intended for sighting and drawing lines of direction when working with a map on the ground during sketching by eye, and is also used for measuring and laying off distances on a map (fig. 8).

Figure 8. Sight rule.



ЛИНЕЙКА МАСШТАБНАЯ
LINEYKA MASSHTABNAYA

Map scale. A ruler (usual metal, about 5x25 cm in size) with an engraved transverse scale; it serves for precise measurements of lengths of lines with dividers on a map.

ЛЕГЕНДА
LEGENDA

Legend. A brief textual explanatory note located on the margins of graphical documents. The legend includes information which cannot be expressed graphically; it also provides conventional symbols which are used in the drawing.

ЛЕТНИК (Летовка)
LETNIK (Letovka)

Summer place. A separate farmstead in the steppe area which is occupied only in the summer.

ЛОКСОДРОМИЯ
LOKSODROMIYA

Rhumb line. A line on a sphere which intersects all meridians at the same angle. The rhumb line is used for laying out the path (course) of a ship (airplane) with a constant true course (direction of movement relative to the points of the compass). In contrast to the orthodrome [ortodromiya] (see) the rhumb line is not the shortest line between terminal points.

ЛОЦИЯ
LOTSIYA

Sailing directions. A description of a water basin which explains and supplements marine navigation charts. The sailing directions provide: the detailed characteristics of the coastal portion of the sea; a general survey of the sea; a description of beacons, markers, and barriers; tables of distances; laws, instructions, and rules which determine the sailing regime, are presented. A list of charts and photographs which distinguish shore points, etc., is provided.

ЛОЦИЯ РЕКИ
LOTSIYA REKI

River sailing directions. A description which supplements and explains pilot charts of navigable rivers.

ЛУННЫЕ ФАЗЫ
LUNNYYE FAZY

Lunar phases. Changes in the visible portion of the moon which occur in connection with the change in the mutual positions of the sun, earth, and moon. The following lunar phases are distinguished: new moon (the moon is not visible or only a thin "crescent" is visible); first quarter (visible is a semicircle of the moon which is turned with its curvature to the right); full moon (the moon has the appearance of a complete, or almost complete, circle); last quarter (visible is the moon's semicircle which faces the left). The time period for the change of all four lunar phases is called the synodical or lunar month (29.5 days).

МАГНИТНОЕ НАКЛОНЕНИЕ
MAGNITNOYE NAKLONENIYE

Magnetic dip. See Terrestrial magnetism [zemnoy magnetizm].

МАГНИТНЫЕ БУРИ
MAGNITNYYE BURI

Magnetic storms. Fluctuations in the earth's magnetic field whose origin is insufficiently studied; they may present a serious obstacle to orientation using a magnetic compass.

МАКЕТ МЕСТНОСТИ
MAKET MESTNOSTI

Terrain model. See relief model of the terrain [rel'yefnyy maket mestnosti].

МАРШРУТНАЯ С"ЕМКА
MARSHRUTNAYA S"YEMKA

Eye sketching of a route. A particular case of military sketching by eye (see), which is performed along a route of movement.

МАСШТАБ
MASSHTAB

Scale. The ratio of the length of a line on a map (plan) or other graphic document to the length of the corresponding line on the ground.

МАСШТАБ ВРЕМЕНИ
MASSHTAB VREMENI

Time scale. A graphic scale [masshtab lineynyy] (see); the values of its divisions are given in measurements of time (usually in minutes) during which these distances will be covered at a certain speed of movement.

МАСШТАБ ЛИНЕЙНЫЙ
MASSHTAB LINEYNYY

Graphic scale. A graphical expression of the representative fraction [masshtab chislennyy] (see), a straight line divided into specific parts which are accompanied by values signifying distances on the ground (Fig. 9). The graphic scale is intended for measuring and laying off distances on a map. In Figure 9, the distance between points A and B is 1,300 meters.

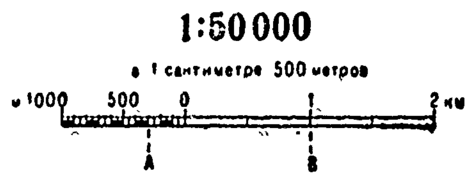


Figure 9. Graphic scale.

Caption above scale - 1 centimeter equals 500 meters.

МАСШТАБ ПОПЕРЕЧНЫЙ
MASSHTAB POPERECHNYY

Transversal scale. A diagram (usually on a metal plate) for measuring and laying off distances on a map with the greatest graphical precision (fig. 10).

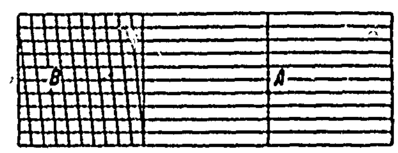


Figure 10. Transversal scale.

The standard (normal) transversal scale has large divisions which equal 2 cm and small divisions (to the left on the diagram) which equal 2 mm; in addition, on the diagram there are segments between the vertical and sloping lines which equal 0.2 mm on the first horizontal line, 0.4 mm on the second line, 0.6 on the third, etc. Using the standard transversal scale, one can measure and lay off distances on a map of any (metric) scale. The reading of distances from a transversal scale consists of the sum of the readings on the base of the diagram and the horizontal line (here, the segment is read which is formed by the vertical and sloping lines). On Figure 10, the distance between points A and B (with a map scale of 1:100,000) is 3480 meters.

МАСШТАБ ПРОПОРЦИОНАЛЬНЫЙ
MASSHTAB PROPORTSIONAL'NYY

Proportional (wedge-like) scale. A diagram of the transfer of segments measured on an aerial photo to the map scale. It is used primarily for the transfer of objects (targets from an aerial photo to a map. (See construction of a proportional scale in Section 5, Chapter IV).

МАСШТАБ ЧИСЛЕННЫЙ
MASSHTAB CHISLENNYY

Representative fraction. The scale of a map (plan) expressed by an abstract number - a fraction, the numerator of which is a unit and the denominator of which is a number which shows the degree of reduction of

terrain lines on the map (more precisely, their horizontal projections); it is printed on maps and is usually accompanied by an indication of the size of the scale - the distance on the terrain (in meters or centimeters) which correponds to one centimeter on the map.

МЕЖЕНЬ
MEZHEN'

Normal water level of a river, low water level. The average, steadiest water level in a river: in the summer, with flatland rivers, in the winter with mountain rivers.

МЕРИДИАН ЗЕМНОЙ ИЛИ ГЕОГРАФИЧЕСКИЙ
MERIDIAN ZEMNOY ILI GEOGRAFICHESKIY

Terrestrial or geographic meridian. The line of intersection of the surface of the earth with a plane drawn through a given point and the earth's axis.

МЕРТВОЕ ПРОСТРАНСТВО
MERTVOYE PROSTRANSTVO

Dead space. A terrain sector behind some cover which cannot be hit by enemy fire. The size of the dead space depends on the nature of the cover and the ballistic properties of the weapon. In the general case, the higher the cover, the flatter the trajectory, and the closer the firing position is located to the cover, the greater the dead space.

МЕСТНОСТЬ
MESTNOST'

Terrain. A portion (section, area) of the earth's surface with all its elements: relief, ground, water, vegetation, routes of communication, populated places, and industrial, agricultural, and socio-cultural objects. The terrain is one of the elements of the combat situation.

Depending on its character and effect on the combat actions of the troops, the terrain is subdivided into the following basic varieties:

according to relief: into flat, hilly, and mountain (low-mountain, average-mountain, and high-mountain);

according to trafficability conditions: into slightly broken (easy to negotiate), average broken (trafficable), and heavily broken (difficult to cross);

according to conditions for observation and concealment: into open, half-closed, and closed;

according to the complex of natural conditions: into desert (desert-eppe), forested (forest-swamp), and terrain of the northern regions.

МЕСТНОСТЬ ГОРНАЯ
MESTNOST' GORNAYA

Mountain relief. Terrain with absolute altitudes above sea level of more than 500 meters; subdivided into low-mountain (absolute altitudes 500-1000 meters), average altitude mountains (absolute altitudes 1000-2000 meters), high mountains (absolute altitudes more than 2000 meters). Varieties of mountain terrain: mountain-forest terrain (mountains overgrown to a considerable degree by timber vegetation) and mountain-desert terrain (mountains almost devoid of vegetation). The timber line in the mountains is indicated in Table 8.

Table 8

Timber line in mountains (according to L. S. Berg)

Mountain areas	Absolute altitude of timber line, meters
Kola Peninsula	350
Western Transcaucasus	1900
Dagestan	2450
Dzhungarian Alatau	2500
Central Tyan-Shan	3200
Eastern Sayans	2000-2400
Altai	2000-2400
Transbaikal	1100-1200
Sikhote-Alin	1000
Sakhalin	450-500
Kamchatka	300-700

Characteristic features of mountain terrain: sharply broken relief (relative differences in altitude of more than 300 meters in 2 km, predominant steepness of slope 5-25°), the presence of numerous obstacles difficult to negotiate, limited number of roads, and difficulty in moving over them. In addition, typical of mountain relief are rivers with rapid currents and with abrupt fluctuations in water level as well as rock slides, snow slides, ice avalanches, and mud streams.

The temperature in the mountains usually drops 0.5 - 0.6° with a rise of 100 meters, and sudden and frequent changes in the weather and temperature fluctuations in the course of a day are frequent.

Possible at high altitudes are strong winds, fogs, downpours, and snowfalls (the snow line in the middle latitudes runs along an altitude of 2500 - 3200 meters; see Table 9) with the simultaneous preservation of dry and warm weather in the valleys.

Table 9

Absolute altitudes of the snow line (according to S.V.Kalesnik)

1 Широта северного полушария, градусы	2 Пределы высоты, м	3 Средняя высота, м
80—70	300—1500	790
70—60	700—1500	1150
60—50	1600—3170	2500
50—40	1600—4300	3170
40—30	2900—6000	4900

Key: 1 - latitude of northern hemisphere, degrees; 2 - altitude limits, meters; 3 - average altitude, meters.

Atmospheric pressure changes significantly in the mountains with an increase in absolute altitudes (see Table 10). Mountain sickness is possible at altitudes above 3 - 5 km. A critical rarefacyion of the air which is dangerous to life is observed at altitudes higher than 8 km above sea level. The rarefaction of the atmosphere also affects the operation of engines; the power of the engines of tanks, automobiles, and other vehicles is reduced by approximately 10% for each 1000 meters of rise.

Table 10

Change in atmospheric pressure with altitude.

1 Высота, м	2 Атмосферное давление, мм	3 Высота, м	4 Атмосферное давление, мм
0	760	3500	493
500	716	4000	462
1000	674	4500	433
1500	634	5000	405
2000	596	5500	378
2500	560	6000	354
3000	526		

Key: 1 - altitude, meters; 2 - atmospheric pressure, mm; 3 - altitude, meters, 4 - atmospheric pressure, mm.

Mountain terrain hinders mass employment of tanks and other heavy equipment. Sharply broken mountain terrain facilitates the organization of ambushes and engineer obstacles and also facilitates concealment, but hinders orientation and observation. Also characteristic of mountain terrain is the screening effect of mountains on the operation of radios and radio engineering means and sound-ranging.

Mountain terrain has a noticeable effect on the action of nuclear weapons. Mountain crests and summits change the nature of propagation of the shock wave, block the path to direct fluxes of thermal radiation and initial radiation, and thereby reduce the zones of damage. At the same time, the overpressure is increased on slopes which face the direction of burst

and in narrow valleys and passes disposed in the direction of propagation of the shock wave. In addition, the formation of rock falls, avalanches, and snow slides is possible. In the valleys, canyons, and gullies the radiation levels observed are higher than at elevated places.

In mountain terrain, particularly in mountain-forest terrain, the persistance of toxic means is increased and the spread of contaminated air along the valleys and canyons over large distances is possible.

In mountain terrain the launching of nuclear strikes, in addition to the destruction of regular targets, is also probable against passes, canyons, and other objects the destruction of which may cause landslides, snowslides, and floods and thereby hinder the movement and actions of troops for a long time.

МЕСТНОСТЬ ЗАКРЫТАЯ
MESTNOST' ZAKRYTAYA

Closed terrain. Terrain with numerous natural masks (it is considered approximately that on closed terrain up to 30% of the area is closed by natural masks and up to 75% cannot be observed from commanding heights).

Typical closed terrain is forest and mountain terrain as well as densely populated terrain with numerous structures, obstructions, and planted areas.

Closed terrain provides complete concealment of troops and rear areas when disposed at the halt and, to some degree, furthers protection against weapons of mass destruction; at the same time, the prolonged stagnation of toxic substances and the formation of landslides is possible on individual sectors.

Observation, orientation, and target indication are hindered on closed terrain.

МЕСТНОСТЬ ЛЕСИСТО-БОЛОТИСТАЯ
MESTNOST' LESISTO-BOLOTISTAYA

Forest-swamp terrain. Forest terrain with numerous swamps and excessively wet soils (see Forest terrain [mestnost' lesnaya]).

МЕСТНОСТЬ ЛЕСНАЯ
MESTNOST' LESNAYA

Forest terrain. Terrain, the major portion of which is covered with timber vegetation (forests). The effect of forest terrain on the actions of troops is determined primarily by the properties of the forest (with flat and hilly relief) and the swampiness of the ground.

The wind is hardly felt in a forest at a distance of 100 - 200 meters from the edge. It is cooler in the forest than in the fields in the summer,

and it is warmer in the winter. Soil in the forest freezes through to a lesser depth than in the fields. Snow disappears in a dense forest 2 - 3 weeks later than in an open location. Approximately 15% of the precipitation is retained on deciduous trees, about 20 - 25% on pine, up to 60% on spruce, and up to 80% on fir.

The subdivision of a forest by age and thickness and the characteristics of trees are shown in Tables 11 to 13.

Table 11

Subdivision of a forest by age.

Type of forest	height of trees, meters	Thickness of trees at base, meters
Young, or pole	4-6	5-15
Medium age	More than 6	About 20
Mature	10 - 15, or more	More than 20 - - 25

Table 12

Subdivision of a forest by density.

Type of forest	Compactness of crowns
Dense	Crowns compact
Average	Distance between crowns no greater than their diameters
Sparse (thin forest)	Distance between crowns up to five diameters or more

Table 13

Characteristics (approximate) of trees growing under good conditions in a forest

Возраст (число лет) a	Густота леса b		Средняя высота деревьев, м e	Средний диаметр деревьев в см на высоте 1,3 м f	Объем плотной древесной массы одного дерева, м³ g
	количество деревьев на 100 м² c	среднее расстояние между деревьями, м d			
20	56	1,5	6	6	0,02
30	35	1,9	10	9	0,06
40	22	2,4	13	12	0,15
50	15	2,9	15	15	0,26
60	12	3,2	18	18	0,46
70	9	3,7	20	20	0,63
80	8	3,9	22	23	0,91
90	7	4,2	24	25	1,18
100	6	4,5	25	27	1,43
110	5	5	25	29	1,65
120	5	5	26	31	1,96
130	5	5	27	32	2,17
140	5	5	28	33	2,39

Key: a - age (number of years); b - density of forest; c - number of trees per 100 m^2; d - average distance between trees, m; e - average height of trees, m; f - average diameter of trees in cm at a height of 1.3 meters; g - volume of solid wood of the mass of one tree, cubic meters.

Trafficability of forest tracts (off roads and trails) depends primarily on the thickness and density of the trees, swampiness of the ground, and relief characteristics. Tanks move relatively freely (without a massive felling of trees) in a forest with trees with a thickness of more than 20 cm and with average distances between trees on the order of 8 meters or more; tanks move only with the mass felling of trees when trees are spaced apart 6 meters or less; such forests (with a thickness of trees of more than 20 cm) are practically impassable for tanks in extended formations.

Forest tracts with numerous swampy sectors, swamps, and streams (forest-swamp terrain) are particularly difficult to negotiate. Under these conditions, troops operate over separate directions, primarily along roads and trails.

Forest terrain promotes concealment but complicated orientation, target indication, and coordination.

Conditions for protection against weapons of mass destruction in forest terrain are favorable for the most part: here, the radii of zones of damage by the shock wave and especially thermal radiation are reduced considerably; in this respect, young deciduous forests possess the best protective properties. It is also necessary to consider the negative properties of forest tracts - stagnation of the vapors of toxic substances and, with nuclear strikes, possible obstructions and fires.

МЕСТНОСТЬ ОТКРЫТАЯ
MESTNOST' OTKRYTAYA

Open terrain. Flat or slightly hilly terrain almost devoid of significant natural masks and cover. It is considered approximately that on open terrain up to 10% of the area of the territory is under natural masks and that more than 75% of the area can be viewed from elevations.

The term "open terrain" is used primarily in evaluating terrain - for the characteristics of its camouflage and protective properties: open terrain is unfavorable from the point of view of protection against weapons of mass destruction and hinders the camouflage of troops.

МЕСТНОСТЬ ПОЛУЗАКРЫТАЯ
MESTNOST' POLUZAKRYTAYA

Semiclosed terrain. According to conditions for camouflage and observation, it occupies an intermediate position between open and closed terrain. It is considered approximately that on semiclosed terrain about 20% of the area is closed by natural masks and about 50% of the expanses cannot be viewed from command posts.

The camouflage of troops against observation from the air with their disposition at a halt on semiclosed terrain is almost completely provided by natural masks.

МЕСТНОСТЬ ПУСТЫННАЯ
MESTNOST' PUSTYNNAYA

Desert terrain. The terrain of deserts and semideserts. Its characteristic features are: extremely poor vegetation, acute shortage or complete lack of water, fuel, and construction materials; low population and poorly developed road net; aric climate with sudden temperature fluctuations in the course of a day (up to 30 - 40°), strong winds (during the day, as a rule, up to 7 - 8 points), soils primarily sandy (sandy deserts) and rocky (rocky deserts).

Movement of troops off roads is frequently possible on desert terrain; barkhan sands, wet salt marshes, and individual sectors of rocky deserts are most difficult to negotiate. Sand and dust have a harmful effect on the operation of engines, running gear of vehicles, armament, and other means. Desert terrain does not further protection against weapons of mass destruction; intensification of the radiological contamination of the terrain and air is observed (the composition of desert soils includes many elements which are capable of forming induced radiation). At the same time, the dustiness of the air reduces the radius of damage by thermal radiation. Objectives of nuclear strikes in the desert, apart from regular objectives, may be vitally important terrain objects: oases, water sources, hydraulic structures, and others. The high temperatures of the desert surface in the summer, winds,

and sandy soils promote the rapid evaporation of toxic substances. At the same time, the open and flat nature of the terrain favors the considerable propagation of contamination of the air. High temperatures, the great dustiness of the air, and the absence of precipitation in the air also favor the employment of bacteriological weapons.

МЕСТНОСТЬ РАВНИННАЯ
MESTNOST' RAVNINNAYA

Flat terrain. Terrain with flat or slightly undulating surface. Absolute altitudes of flat terrain usually do not exceed 300 meters, relative altitude differences in 2 km are up to 25 meters, and the predominant steepness of slopes is up to 1°.

The tactical properties of flat terrain may be extremely varied and depend primarily on the nature of the soil-ground and vegetational cover as well as on the degree to which the terrain is broken by various obstacles.

МЕСТНОСТЬ СЕВЕРНЫХ РАЙОНОВ
MESTNOST' SEVERNYKH RAYONOV

Terrain of the northern regions. Polar and Arctic terrain, mountain and plain tundras, characterized by an extremely sparse network of roads, great humidity of the ground-soils, an abundance of surface water, an absence of trees, severe climate with a prolonged winter, permafrost, sudden fluctuations of meteorological conditions, and frequent ionospheric and geomagnetic disturbances (storms). Characteristic of areas of the extreme North (beyond the Arctic Circle) are long polar nights (from 10 days at a latitude of 67° to 77 days at 73°) and polar days (from 32 days at a latitude of 67° to 97 days at 73°).

The terrain of the northern regions has a significant influence on the actions of troops. The snow cover is higher than 80 - 100 cm in the winter and limits, and sometimes excludes, with the absence of a firm frozen snow crust, the movement of tanks off roads. In glacial regions ice hummocks which have cracked in the ice are a serious obstacle to the movement of troops. Rivers, lakes, and even swamps may serve as convenient routes of movement in the winter. In the summer vast areas of flat tundra are converted into swamps difficult to negogiate for troops. Combat actions of troops under conditions of the northern regions are typical alon roads, paths, and other accessible directions.

МЕСТНОСТЬ СРЕДНЕПЕРЕСЕЧЕННАЯ
MESTNOST' SREDNEPERESECHENNAYA

Average broken terrain. Primarily hilly, more rarely flat; it is considered approximately that on average broken terrain about 20% of the area of a region is occupied by natural obstacles. Average broken terrain is trafficable almost everywhere for heavy combat equipment.

Average broken terrain is the most widespread variety of terrain well inhabited and assimilated by man; norms in the regulations usually correspond to conditions of average broken terrain.

МЕСТНОСТЬ ХОЛМИСТАЯ
MESTNOST' KHOLMISTAYA

Hilly terrain. Terrain with a wavelike surface formed by depressions (valleys, ravines, gullies) and elevations (hills, mounds, low rides, etc.). Absolute altitudes of hilly terrain do not exceed 500 meters and most often are within limits of 200 - 400 meters; relative differences in elevation in 2 km are 25 - 200 meters; the predominant steepness of slopes is on the order of 2 - 3°.

Hilly terrain may be extremely varied in its tactical properties, but is primarily average broken and semiclosed in nature.

МЕСТНЫЕ ПРЕДМЕТЫ
MESTNYYE PREDMETY

Local objects. All objects created by man which are located on the terrain (populated places, individual structures, plants, roads, canals, gardens, etc.) and of natural origin (forests, rivers, swamps, etc.) except for elements of relief; they are depicted on topographic maps by special conventional symbols.

НАВИГАЦИОННАЯ АППАРАТУРА
NAVIGATSIONNAYA APPARATURA

Navigating equipment (of ground vehicles). Instruments for orientation which can be installed in combat, special, and transport vehicles (tracked and wheeled).

The basic instruments of navigating equipment are:

course pointer, records the direction of movement and angles of turn of the vehicle;

route data unit, records the distance covered by the vehicle;

computer, continuously (automatically) converts course and distance recorded by course pointed and route data unit into rectangular coordinates;

course plotter, a plotting board with a plotting mechanism which automatically draws on a map the route covered by the vehicle;

angle-measuring device, aiming circle, chord-angle measurer, and other instruments necessary for the staring (initial) orientation of the vehicle - for the determination of the vehicle's course (Y-azimuth of the vehicle's longitudinal axis) and rectangular coordinates of the initial point.

The instruments of the navigating equipment are equipped with a system of reading devices permitting knowing the course at any moment of movement (Y-azimuth of the direction of movement), distance covered, rectangular coordinates of the vehicle, and other data.

Depending on their purpose individual vehicles are equipped with an incomplete outfit of instruments of navigating equipment.

Navigating equipment of ground vehicles automates orientation to a considerable degree, and permits keeping to a given (selected) direction of movement and arriving at the required area exactly under any terrain and visibility conditions. (See Chapter VIII, Employment of Navigating Equipment in Orientation).

НАЧАЛЬНЫЙ МЕРИДИАН
NACHAL'NYY MERIDIAN

Reference meridian. The geographic meridian which is taken as the origin for calculating longitude. In the USSR, as in the majority of other states, the Greenwich meridian is taken as the reference meridian.

НИВЕЛИРОВАНИЕ
NIVELIROVANIYE

Levelling. Determination of the altitudes of points on the earth's surface relative to some selected point or above sea level. Three types of levelling are distinguished: geometric, geodetic (trigonometric), and barometric. Geometric levelling is accomplished by sighting with a horizontal ray and reading the difference in heights from rods. Geodetic (trigonometric) levelling consists of determining the difference in altitudes from a vertical angle and from a distance. Barometric levelling consists of determining the difference in altitudes from the difference in atmospheric pressure.

НОМЕНКЛАТУРА КАРТ
NOMENKLATURA KART

Map nomenclature. A system for designating sheets of topographic maps. The nomenclature of maps is directly connected with the ruling of the sheets. The frames of the sheets of topographic maps of the USSR are primarily meridians and parallels. On some topographic maps of capitalist states the frames of the sheets are served by lines of the kilometer grid.

The nomenclature of topographic maps of the USSR have as their basis the nomenclature of a map of a scale of 1:1,000,000, which consists of a capital letter of the Latin alphabetdesignating the zone (origin for reading, from the equator, further, to the north and south), and Arabic numbers designating the number of the column (origin for reading, from the 180th meridian to the east, from 1 to 60, see fig. 21). Map sheets of a scale of 1:500,000 are obtained as a result of dividing a sheet of a 1:1,000,000 map into four parts. Their designation includes the nomenclature of the sheet of the 1:1,000 map with the addition of a capital letter of the Russian alphabet (А, Б, В, Г; see fig. 22). The order for dividing the initial sheet to obtain map sheets of a larger scale are indicated in Table 14.

Table 14

Summary table of the ruling, dimensions, and nomenclature of map sheets

Масштаб карты a	Исходный лист для разграфки данного b	Количество листов в исходном c	Размеры листа d		Обозначение (нумерация листов в исходном) g	Типовая запись номенклатуры h
			по широте e	по долготе f		
1:1 000 000	Исходный	1	4°	6°	—	N—35
1:500 000	1:1 000 000	2×2=4	2°	3°	А, Б, В, Г	N—35—7
1:200 000	1:1 000 000	6×6=36	40′	1°	I, II,...,XXXVI	N—35—XXXVI
1:100 000	1:1 000 000	12×12=144	20′	30′	1, 2,..., 144	N—35—144
1:50 000	1:100 000	2×2=4	10′	15′	А, Б, В, Г	N—35—144—Г
1:25 000	1:50 000	2×2=4	5′	7′,5	а, б, в, г	N—35—144—Г—г
1:10 000	1:25 000	2×2=4	2′,5	3′,75	1, 2, 3, 4	N—35—144—Г—г—4

Remarks: 1. The numerical and letter numbering within the initial sheet increases from left to right and from top to bottom.

2. North of the 60th parallel, map sheets are published in pairs, and north of the 76° parallel, quadruples for longitude (fig. 21).

3. Map sheets of a scale of 1:200,000 were formerly issued quadrupled for some territories. Listed in the notes were all sheets covered by the quadruple sheet. A typical note of the nomenclature of quadrupled sheets: N - 35 - XXIX, XXX, XXXV, XXXVI.

Key to table: a - map scales; b - initial sheet for ruling the given sheet; c - number of sheets in the initial sheet; d - dimensions of sheet; e - for latitude; f - for longitude; g - designation (numbering of sheets in initial sheet) h - typical nomenclature note.

As can be seen from the table, the nomenclature of maps of a scale of 1:200,000 consists of the nomenclature of a sheet of a 1:1,000,000 map with the addition of the Roman numerals (1-XXXVI, see fig. 23), the nomenclature of maps of 1:100,000 with the addition of Arabic numbers (1-144, see fig. 24). The nomenclature of maps of 1:50,000 consists of the nomenclature of maps of 1:100,000 with the addition of letters of the Russian alphabet (А, Б, В, Г, see fig. 25). The nomenclature of map of 1:25,000 consists of the nomenclature of a map of 1:50,000 with the addition of a lower case letter of the Russian alphabet (а, б, в, г, see fig. 25).

ОБЗОР МЕСТНОСТИ
OBZOR MESTNOSTI

View of the terrain. The possibility of encompassing (seeing) the surrounding terrain with a glance. The view (degree to which looked over) of a terrain sector (zone) depends on the nature of the relief, the presence of vegetation (forests, gardens, etc.), populated places, and individual structures, as well as on the time ofay and meteorological conditions.

Viewing conditions which depend on the nature of the terrain may be studied with sufficient completeness from topographic maps with a scale of 1:25,000 - 1:100,000 and aerial photos.

ОБЗОРНАЯ КАРТА
OBZORNAYA KARTA

General map. A splicing of topographic maps of a scale of 1:100,000, 1:200,000, or 1:500,000 (sometimes 1:1,000,000) on which the following are accented (by underlining, increasing subscripts or conventional signs, shading, washing): the most important objects on the terrain (basic relief forms, main populated places, roads and water obstacles, engineer structures on roads and rivers) and the basic qualitative characteristics of these terrain elements and objectives are given. Sometimes, the general map may reflect data on the protective and concealment properties of the terrain, as well as on trafficability conditions.

ОВРАГ
OVRAG

Gully

A negative relief form created by temporary and small, permanent. currents of water, with steep slopes (walls). Gullies are formed primarily on clay and loamy soils. In length they are from tens of meters to several kilometers, in width up to several tens of meters, and up to 10 meters or more in depth.

ОГНЕВОЙ ГРЕБЕНЬ
OGNEVOY GREBEN'

Fire crest. The name sometimes used for military crest [boyevoy greben'] (see).

ОПИСАНИЯ МЕСТНОСТИ
OPISANIYA MESTNOSTI

Terrain description. Military geographic descriptions compiled for operational directions, theaters of military operations, or parts of them; various types of handbooks on the terrain. All enumerated terrain descriptions which are illustrated by photographs, drawings, diagrams, tables, etc., include generalized data on the terrain, as well as data which cannot be expressed on maps: seasonal changes, composition of the population, information on the economy of a region, climatic conditions, etc. Military topographic descriptions present greater particulars and details; data of military-geographic descriptions have a more generalized character. Special handbooks on the terrain are compiled occasionally for the accomplishment of a specific task.

ОПОРНАЯ ГЕОДЕЗИЧЕСКАЯ СЕТЬ (ОГС)
OPORNAYA GEODEZICHESKAYA SET' (OGS)

Geodetic control net. The aggregate of points which are affixed to the terrain by special markers (underground and on the surface), the coordinates of which and the Y-azimuths of which (to other points or special markers) are determined with a given accuracy. The geodetic control net includes:

state geodetic net (see);

special purpose geodetic net (OGSS);

special purpose net of reference points (ORSS).

Special purpose geodetic nets (OGSS) and special purpose nets of reference points (ORSS) are developed (intensified) on the basis of points of the state geodetic net. The rectangular coordinates of OGSS points are usually determined with mean errors of no more than 2 meters and Y-azimuths of sides of the OGSS and ORSS and lines of direction to individual reference points are determined primarily with mean errors of no more than 1'. The coordinates of ORSS points are determined from topographic maps of a larger scale.

ОРИЕНТИР
ORIENTIR

Reference points. Any object (relief detail) of the terrain which is easily noticeable (distinguishable) against the surrounding background.

Reference points are widely used to indicate one's location, direction of movement, positions of rargets, and other objects.

In combat, reference points are selected and indicated by the senior commander. The reference points are numbered from right to left and by terrain lines (from one's self in the direction of the enemy). For convenience in recalling reference points, they are sometimes given code designations which reflect their most characteristic features, for example, "House with the blue roof," etc.

ОРИЕНТИРОВАНИЕ
ORIENTIROVANIYE

Orientation (topographic). Determination of own location with respect to the directions of the compass and reference points (local objects and relief elements), as well as the clarification of the situation, on the terrain, of its individual elements, friendly troops, the enemy, and other objects, adhering to an assigned or selected direction of movement (route). Depending on the situation, degree of equipping with technical means, terrain conditions, and visibility, various methods of orientation are used (see Chapters VII and VIII).

ОРТОДРОМИЯ
ORTODROMIYA

Orthodrome. The shortest distance between two points on the earth's surface. If the earth is taken as a globe, the orthodrome represents an arc of the great circle. On the terrestrial spheroid, the orthodrome is a complex curve which is called a geodetic line (see).

ОСУШКА
OSUSHKA

Dry area. A strips of the seacoast which dries out during low tide.

ОСЫПИ
OSYPI

Talus. An accumulation of fragments of broken rock on mountain slopes. Sometimes the talus slides, seems to flow, along the mountain slopes, particularly when their state of rest is disturbed. Talus slopes are shown on topographic maps by means of special conventional signs.

ОТМЕТКА ВЫСОТЫ
OTMETKA VYSOTY

Altitude reading. On a map, a spot printing of the absolute altitude of points on the terrain. It should be kept in mind that altitude readings

found on topographic maps are not always the crests of heights; they may be on the slopes and even on rivers, lakes (see water's edge [urez vody]).

ОТМЫВКА
OTMYVKA

Shading. The tinting with color or tone of a height or sharpness of relief, as well as the depths of bodies of water (seas, lakes, rivers) on maps. It is used as a supplement to contour lines on some general geographic and special maps.

ОТНОСИТЕЛЬНОЕ ПРЕВЫШЕНИЕ
OTNOSITEL'NOYE PREVYSHENIYE

Relative altitude difference (relative altitude). The height of one point of the earth's surface above another (of a crest above the foot of the slope, etc.).

ОЦЕНКА КАРТЫ
OTSENKA KARTY

Appraisal of map. Acquaintance with a topographic map in preparing it for work. In appraising a map, a clarification is made of the map scale, contour interval, year of photography or preliminary survey, number and year of photography or preliminary survey, number and year of publication, directional correction (for greater detail, see Section 3, Chapter II).

ПАНОРАМА
PANORAMA

Panorama (panoramic telescope). 1. An artillery optical instrument, a component part of a gun sight for field artillery; it permits conducting an all-round survey without changing the gunner's position. 2. An oblique sketch of the terrain with an angle-measuring grid plotted on it; used for fire control of field artillery.

ПАНТОГРАФ
PANTOGRAF

Pantograph. An instrument for redrawing graphical documents with a reduction or increase in scale.

ПАРАЛЛЕЛИ
PARALLELI

Parallels. Lines for cutting the surface of the earth by planes which are parallel to the earth's equator [ekvator zemnyy] (see); all points which lay on a given parallel have the same geographic latitude.

ПЕЛЕНГ
PELENG

Bearing. A synonym for magnetic azimuth (see); the term is used in the Navy. To take a bearing means to intersect or determine the location of an object of interest.

ПЕРЕВАЛ
PEREVAL

Pass. The place which is lowest and most accessible for passage on a mountain crest or mountain mass.

ПЕРЕГИБ СКАТА
PEREGIB SKATA

Bend of a slope. A line of sudden change in the steepness of a slope from a steeper to a gentler slope or vice versa.

ПЕРЕКАТ
PEREKAT

Bar. Ashallow portion of a river, usually most accessible for fording. The basic indicator of a bar is a widening of the river channel.

ПЕРСПЕКТИВНАЯ С"ЕМКА
PERSPEKTIVNAYA S"YEMKA

Oblique survey. A visual drawing of the terrain from one point for the purpose of obtaining an oblique survey or panorama (see). As ground photography instruments are introduced among the troops, oblique surveys are losing its independent significance.

ПЕСКИ
PESKI

Sands. A surface continuously covered by sand (fine fragments, most often quartz grains with a size of from 0.05 to 2 mm), poorly fixed or not fixed by vegetation.

The following sands are distinguished: flat, hummocky, dune, ridged, barkhan, alveolar, and cellular. The external drawing of sandy surfaces is reproduced on modern topographic maps by a pointed image which recalls their photography obtained from the air. In adddition, large forms of more or less stable sands are expressed by contour lines.

Most difficult to negotiate are dune and barkhan sands which are not fixed by vegetation.

ПЛАВНИ
PLAVNI

Flooded areas. Swampy portions of river floodplains and deltas, usually overgrown with reeds and cane. As a rule, the flooded areas abound with lakes.

ПЛАН
PLAN

Plan (topographic), the representation on paper in an orthogonal projection, of a small section or object of the terrain. Plans are usually compiled in large scales; as a rule, local objects are characterized on them in greater detail than on maps.

A variety of topographic plans are plans of cities, railroad junctions, naval bases, etc., which are widely used by troops in organizing and conducting battle for these points. As a rule, located on a city plan are not only data on ground objects but also on underground objects (subway, sewage systems, communications commutators, etc.), the names of streets are given (directly on the plan or in a list on the margins with the indication of their location by grid square, specially plotted on the plan for this), a detailed list of the most important objects is indicated, and information is provided which gives the political, economic, and military characteristics of a given place. City plans are sometimes created on a photographic base, i.e., in the form of photo plans.

ПЛАНШЕТ
PLANSHET

Plotting board. 1. A square board used for the gluing together of paper in producing topographic surveys; it is part of the plane table kit. 2. The survey original of a map sheet. 3. A case (portfolio) for working with a map under field conditions.

ПЛЕС
PLES

Reach. A deep section of a flatland river, usually with a quiet current.

ПЛОСКОГОРЬЕ
PLOSKOGOR'YE

Plateau. A section of flatland terrain located at a considerable height above sea level.

ПЛОТИНА
PLOTINA

Dam. A hydraulic structure for raising water. The dams of hydroelectric power stations have a water jump of up to 20 meters or more. With dams which are erected only for navigational purposes, the water jump usually does not exceed 2-3 meters.

ПЛЯЖ
PLYAZH

Beach. The gently sloping alluvial shore which is covered by sand, gravel, or pebbles.

ПОБЕРЕЖЬЕ
POBEREZH'YE

Coast. A part of the land which abuts directly on the shore of a sea lake.

ПОДОШВА
PODOSHVA

Foot. The base of a mountain, hill, or other elevation. The foot represents the line for transition from the horizontal or slightly sloping surface to a steeper slope.

ПОЙМА
POYMA

Floodplain. A part of a river valley which is inundated during high water. The floodplain of a large river is usually separated from the channel by a steep bench ("gill") which has been washed out or a strip of channel sands. The floodplain is usually cut up by streams and oxbow lakes. On the outer side, the floodplain is limited by a gently sloping rock slope or ledge of a terrace.

ПОЛЕВАЯ ДОРОГА
POLEVAYA DOROGA

Field road. A dirt road of local significance, usually seasonal (for field work, etc.) and which stops abruptly in the field.

ПОЛНЫЕ КООРДИНАТЫ
POLNYYE KOORDINATY

Complete coordinates. Rectangular coordinates which are written (designated) completely without any abbreviations.

ПОЛЯРНАЯ ЗВЕЗДА
POLYARNAYA ZVEZDA

Pole star. A bright star of the Little Dipper constellation which is located in the direction of the earth's North Pole (deviation about 1°). The Pole Star is widely used for orientation: for determining direction to the north and the gwographic latitude of a point. The latitude of a point is approximately equal to the elevation of the Pole Star above the horizon.

ПОЛЯРНЫЕ КООРДИНАТЫ
POLYARNYYE KOORDINATY

Polar coordinates. Values which determine the position of a point on a plane relative to a point which is taken as a pole. Such values are the position angle which is read from the line of direction of the polar axis in a clockwise direction and the distance from the pole to the point being determined. Polar coordinates are used in moving by azimuths in target indication on the battlefield, etc.

ПОПРАВКА НАПРАВЛЕНИЯ
POPRAVKA NAPRAVLENIYA

Correction for direction. The acute angle included between the line of direction of a vertical line of a coordinate grid and the line of direction of the magnetic needle of a compass. It equals the algebraic difference between the angle of declination of the magnetic needle (see) [skloneniya magnitnoy strelki] and the covergence of meridians (see) [sblizheniya meridianov] taken with their signs

$$П = \delta - \gamma,$$

where

$П$ is the correction for direction;

δ is the declination of the magnetic needle;

γ is the convergence of the meridians.

In the artillery, it is customary to determine the size of the correction for direction as the difference between the convergence of the meridians and the declination of the magnetic needle:

$$П = \gamma - \delta.$$

ПОЧВА
POCHVA

Soil. The surface layer of the earth's crust which possesses fertility and which bears the plant cover. The basic types of soil on the earth, under the influence of climate, are disposed in zones (belts) from the poles toward the equator.

Tundra soils occupy the northern areas with a moist and cold climate. Tundra soils are saturated with water, are swampy to a considerable degree, and are most often permafrost to some depth. They are difficult to negotiate during the warm time of the year.

Podzolized soils are formed under a forest cover in regions of temperate climate where more precipitation falls than evaporates. The upper layers of the podzols contain a small quantity of soluble salts, lime, iron, and aluminum; in these layers there is much quartz which colors them in a whitish color similar to the color of ashes. The lower layers of the podzols contain more clayey particles than the upper layers; they are more compact and difficult to water to penetrate, which furthers the formation of swamps. Terrain with podzol soils, particularly sandy loams, have comparatively good trafficability. Black earth soils are characterized by a black color and high fertility and, in their mechanical composition, are primarily clayey and loamy. During the period of the thaw, the black earths form considerable thickness of mud. The composition of black soil has few elements which are capable of forming induced radiation but somewhat more than in the podzolized soils.

Chestnut soils are located south of the black dirt soils, in mechanical composition are primarily clayey and loamy, in a wet state possess considerable plasticity and tackiness, and are close to the black dirt soils in trafficability. Chestnut soils are somewhat saline and many salterns and salt bottoms are widespread in their zone.

Gray soils are soils of the semidesert and desert; numerous salt bottoms are widespread in their zone. Gray soils are primarily sandy loam and sandy soils. Their trafficability is completely satisfactory.

Salt bottoms are soils saturated with salts. In their upper layers typical salt bottoms contain 1% or more of soluble salts.

Salterns are also saline soils, but are considerably less so than salt bottoms.

Salt bottoms and salterns are widespread in arid regions where less precipitation falls than is evaporated and which promotes the emergence of the salts in the surface layers. The large content of salts promotes the great capability of these soils for the formation of induced radiation.

ПРЕДЕЛЬНАЯ ГРАФИЧЕСКАЯ ТОЧНОСТЬ
PREDEL'NAYA GRAFICHESKAYA TOCHNOST'

Maximum graphic precision. The smallest possible value which in practice can be recorded and considered in graphic measurements and laying off distances on a map (plan). It is customary to consider it as equal to 0.1 mm.

ПРЕДЕЛЬНАЯ ТОЧНОСТЬ МАСШТАБА
PREDEL'NAYA TOCHNOST' MASSHTABA

Maximum scale precision. The distance on the ground which corresponds to 0.1 mm on a map, i.e., the maximum graphic precision. The maximum scale precision for maps of various scales equals respectively: 1:10,000, 1 meter, 1:25,000, 2.5 meters, 1:50,000, 5 meters, 1:100,000, 10 meters, 1:200,000, 20 meters, 1:500,000, 50 meters, 1:1,000,000, 100 meters.

ПРОМИЛЛЕ
PROMILLE

Pro mille. One thousandth of something. It is designated by 0/00. It is often used for the characteristic of the slope of rivers and roads. The slops of 1 ‰ signifies that the road (water surface of a river) drops 1 meter in a distance of 1,000 meters.

ПРОМОИНА
PROMOINA

Washout. A narrow gully (see) with vertical slopes.

ПРОФИЛЬ
PROFIL'

Profile. A drawing portraying the cross section of terrain by a vertical plane along a given direction called the profile line. The following are distinguished: a complete profile (which reflects all the irregularities on the map) and a reduced profile (with some generalizations). To express the relief of the terrain to ghe greatest degree, the vertical scale of the profile is taken as 10 tomes (or more) the horizontal scale. In this connection, a profile which strictly presents the mutual altitude difference of points distorts (increases) the steepness of slopes (for the construction of a profile from a map, see Section 4, Chapter III).

ПРОХОДИМОСТЬ МЕСТНОСТИ
PROKHODIMOST' MESTNOSTI

Trafficability of terrain. One of the basic properties of the terrain which characterizes the conditions for the movement of troops off roads and the accessability of terrain in general. Trafficability of the terrain is determined by the relief, soil-ground and vegetational cover, hydrographic net, routes of communication, and the time of year and weather conditions.

ПРЯМОУГОЛЬНЫЕ КООРДИНАТЫ
PRYAMOUGOL'NYYE KOORDINATY

Rectangular coordinates (plane). Two linear values x and y, which determine from the shortest distances (perpendiculars) the position of a point on a plane relative to two mutually perpendicular lines; these lines are called the coordinate axes, and the point of their intersection is the origin of the coordinates. In mathematics, the horizontal line is called the abscissa (X) and the vertical line is called the ordinate (Y). In topography (geodesy) the position of the coordinate axes is turned 90°; the vertical line is taken as the abscissa (it coincides with the north-south direction) and the horizontal line is taken as the ordinate.

The system of rectangular (plane) coordinates adopted in the Soviet Union in topography (geodesy) is constructed in the following manner. The terrestrial ellipsoid is divided into 60 zones by meridians with longitude which is the multiple of 6°. The first zone is bounded by the 0° and 6° meridians, the second zone, by 6° and 12°, etc. The numbering of the zone proceeds from the Greenwich meridian from west to east. The territory of the Soviet Union is located within 29 zones: from the 3d to the 31st inclusive. The length of each zone from north to south is on the order of 10,000 km. The width of zone at the equator is about 670 km, at latitude 40°, 510 km, at latitude 50°, 430 km, and at latitude 60°, 335 km.

Each zone (and all topographic maps within the limits of the zone) has its own system of rectangular coordinates. The origin of the coordinates is served by the point of intersection of the central meridian of the zone with the equator. The X-axis is the central (principal) meridian of the zone, while the equator serves as the Y-axis (fig. 11). In order not to have to work with the signs of the coordinates and, thereby, to accelerate target indication on a topographic map, the origin of the coordinates in each zone is shifted 500 km to the left along the Y-axis. Therefore, the y' coordinates read from the map are arbitrary. The determination of the actual coordinates of y is performed from the formula

$$y = y' - 500 \text{ km},$$

where

y' is the coordinate of the point determined from the map.

So as to make it possible to determine the position of a point on the terrestrial spheroid from rectangular coordinates, the number of the zone should be added to the value of the coordinate on the left.

Example. Target coordinates are determined from a map:

$$x = 5\ 650\ 420;$$
$$y = 3\ 621\ 510.$$

Let us calculate their value.

1. The target is located to the north of the equator at a distance of 5650 km 420 meters.

2. The target is located in the 3d zone (No. 3).

3. The distance of the target from the arbitary meridian y' = 621 km 510 meters.

4. The target is located to the right of the principal meridian of the zone at a distance of 121 km 510 meters (621 510 - 500 000).

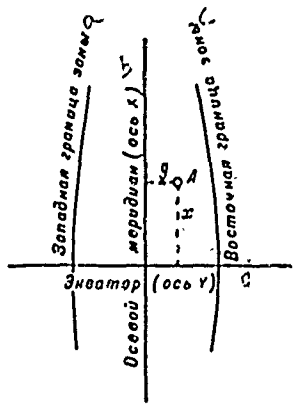


Figure 11. Rectangular coordinates.

a - western boundary of the zone; b - axial meridian (X-axis); c - eastern boundary of the zone; d - equator (Y-axis).

ПУТЕПРОВОД
PUTEPROVOD

Viaduct. A bridge structure for the passage of one road above another.

РАЗВЕДКА МЕСТНОСТИ
RAZVEDKA MESTNOSTI

Terrain reconnaissance. The collection and systematization of information about the terrain: the character and special features of the relief, soil-ground, hydrographic network, populated places, routes of communication, and vegetational cover; disclosure of the presence and nature of natural cover and other terrain objects which determine its protective properties, trafficability conditions, orientation conditions, concealment, water supply, etc.

РАЗВЕДЫВАТЕЛЬНАЯ КАРТА
RAZVEDYVATEL'NAYA KARTA

Reconnaissance map. A topographic map with data printed on it concerning defensive structures, obstacles, firing positions, control posts, and other objects which characterize the defense system and the location, strength, and weapons of the enemy. The reconnaissance map also reflects significant changes in the terrain and other terrain information. The reconnaissance map is compiled from materials from aerial photography with the use of other reconnaissance data.

РАЗГРАФКА ЛИСТОВ КАРТ
RAZGRAFKA LISTOV KART

The ruling of map sheets. See Map nomenclature [nomenklatura kart].

РЕДКОЛЕСЬЕ
REDKOLES'YE

Open forest. An open forest which permits conducting combat operations in normal combat formations of motorized rifle and tank troops. On topographic maps, open forests are shown by a special conventional symbol.

РЕКОГНОСЦИРОВКА
REKOGNOSTSIROVKA

Reconnoitering. 1. Reconnaissance of the terrain and the enemy performed personally by the commander, primarily in the process of working out and making a decision. 2. Investigation of the terrain for the purpose of studying it and determining measures for its use and improvement (route reconnaissance, reconnoitering of assembly areas, etc.). 3. Investigation of the terrain for the purpose of correcting and supplementing a topographic map (topographic reconnoitering).

РЕЛЬЕФ
REL'YEF

Relief. The aggregate of irregularities of the earth's surface. Typical forms of relief are mountain, ridge, depression, basin, saddle.

РЕЛЬЕФНЫЙ МАКЕТ МЕСТНОСТИ
REL'YEFNYY MAKET MESTNOSTI

Terrain relief model. A generalized reduced model of the terrain made from locally available materials, sand, clay, snow. It is intended for gaming a planned battle (operation) under combat and training conditions (see Chapter X for the technique of preparation).

РЕФРАКЦИЯ
REFRAKTSIYA

Refraction. The bending of light rays in the atmosphere in connection with its heterogeneity. The actual distance of the visible horizon, due to the phenomenon of refraction, is increased up to 10% in comparison with the distance which would be obtained with the strict straight-line propagation of the rays. Refraction is considered in determining the conditions for optical and radar (in the millimeter-centimeter band) observation over a distance of 5 km or more (for greater detail, see Section 3, Chapter V).

РИФЫ
RIFY

Reefs. Sharply expressed elevations of the bottom of seas and oceans above and beneath the water which are dangerous for navigation; they are shown on maps.

РОКАДА
ROKADA

Rocade. Roads (railroads, highways, dirt) in the area of combat operations which run approximately parallel to the front line.

РУМБ
RUMB

Bearing. The angle between the northerly or southerly direction of a meridian and a given line of direction, the course of a ship, wind direction, etc. The bearing is read in both directions from the nearest meridian direction, north or south. The size of the bearing cannot be greater than 90°. The bearing is always accompanied by an indication of the quarter of the horzon in which the given line of direction is located. The quarters of the horizon are designated by the first letters of the directions of the compass: NE (northeast), SE (southeast), SW (southwest), NW (northwest). For example: NW 18° means that the bearing is read from the northern direction of the meridian to the west and equals 18°.

Bearings are used in sea navigation, meteorology, land management, and other fields.

РУСЛО
RUSLO

Channel. The bed of a river in which it flows in normal times; during high water, the river flows out of the channel and inundates the floodplain (see). The nature of the channel's structure, including the position of

the waterway (see [farvater]) is presented in fig. 12.

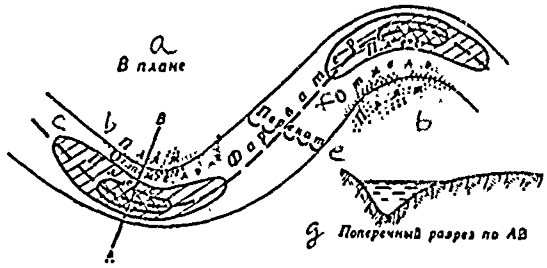


Figure 12. River channel.

a - plane view; b - beach; c - reach; d - waterway; e - bar; f - shallows; g - transverse cross section through AB.

САКСАУЛ
SAKSAUL

Haloxylon. A draught-resistant woody plant of the desert of Central Asia up to 6-10 meters in height with a hard but brittle wood.

САРДОБА
SARDOBA

[No English equivalent] An artificial reservoir with a dome brick superstructure in the waterless areas of Central Asia. The dimensions of sardobas are up to 17 meters in diameter and up to 15 meters deep.

СБЛИЖЕНИЕ МЕРИДИАНОВ
SBLIZHENIYE MERIDIANOV

Convergence of meridians. The angle between the geographic meridian of a given point and the vertical line of the kilometer grid or line parallel to it. The amount of convergence of meridians increases with an increase in the latitude of the point and its distance from the central meridian of the zone; on topographic maps of the USSR it does not exceed 3°. The amount of convergence of the meridians for the central (middle) point of a map is printed in the southwestern corner of the sheet. For any point on the map, the amount of convergence of meridians may be determined from the formula

$$\gamma = yK,$$

where

γ is the convergence of the meridians in minutes;

y is the ordinate of the given point in km;

K is a factor the size of which depends on the abscissa of the given point (Table 15).

Example. Let us determine the convergence of meridians at a point with coordinates:

$$x = 6\ 019\ 425;$$

$$y = 3\ 455\ 680.$$

We round off the value of the x-coordinate to tens of kilometers ($x = 6020$ km) and, from the table, we find (for $x = 6020$ km) the corresponding value of the factor: $k = 0.749$.

We convert the arbitrary value of the ordinate to the actual value read from the central meridian and round it off to tenths of a kilometer (3, number of zone, 455 680 meters - 500 km = -44320 meters); i.e., $y = -44.3$ km. Consequently,

$$\gamma = -44.3 \cdot 0.749 = -33.2' \doteq -0°33'.$$

Table 15

Table for calculating convergence of meridians.

x, км	K	d	x, км	K	d	x, км	K	d	x, км	K	d
4000	0,393	13	5100	0,558	18	6100	0,769	26	7100	1,102	45
4100	0,406	14	5200	0,576	18	6200	0,795	27	7200	1,147	49
4200	0,420	13	5300	0,594	19	6300	0,822	29	7300	1,196	51
4300	0,433	15	5400	0,613	20	6400	0,851	31	7400	1,247	55
4400	0,448	14	5500	0,633	20	6500	0,882	31	7500	1,302	61
4500	0,462	15	5600	0,653	21	6600	0,913	34	7600	1,363	64
4600	0,477	15	5700	0,674	23	6700	0,947	35	7700	1,427	
4700	0,492	16	5800	0,697	23	6800	0,982	38			
4800	0,508	16	5900	0,720	24	6900	1,020	40			
4900	0,524	17	6000	0,744	25	7000	1,060	42			
5000	0,541	17	6100	0,769		7100	1,102				
5100	0,558										

СБОРНАЯ ТАБЛИЦА
SBORNAYA TABLITSA

Index map. A scl[illegible] small-scale map indicating the ruling and nomenclature of topographic maps of one, and sometimes of two or three scales. Index maps are used to determine the nomenclature of map sheets in preparing requisitions for maps as well as for a graphic record of map supplies (see Figures 20, 21).

СЕДЛОВИНА
SEDLOVINA

Saddle. A depressed part of a ridge which recalls a saddle by its shape; in the mountains, it is the location of a pass (see) across a mountain ridge, as a rule.

СИСТЕМА КООРДИНАТ 1942 Г.
SISTEMA KOORDINAT 1942

1942 coordinate system. The arbitrary designation of the system of geodetic coordinates used in the USSR. In 1942, the Soviet scientists F. N. Krasovskiy, A. A. Izotov, and others, completed work on making the earth's dimensions more precise. Used formerly in the USSR were dimensions of the earth determined by the German scientist Bessel in 1841. The average radius of the earth according to Krasovskiy is 6,371,118 meters, according to Bessel, 6,370,290 meters. Made more precise simultaneously with the establishment of the earth's dimensions were the coordinates of the Pulkovskiy astronomic observatory - the initial point for determining geodetic points (see geodetic coordinates).

In 1946, by decree of the Soviet government, the refined dimensions of the earth and coordinates of the Pulkovskiy observatory were adopted as mandatory in determining the coordinates of geodetic points and creating maps. Since this time, topographic maps have been published in the 1942 coordinate system.

Maps published in the 1942 coordinate system have several special features in comparison with maps published earlier; the dimensions of the map borders were somewhat increased (up to 0.1 mm), the distribution of th map borders relative to the terrain objects was changed, and, what is most significant, the position of the coordinate grid relative to the borders of the maps and terrain objects was changed.

СКАТ
SKAT

Slope. The inclined surface of relief forms. The basic elements of a slope are (fig. 13):

steepness, angle of incline of the slope to a horizontal plane;

height, the vertical distance of the highest point above the lowest;

horizontal projection of the slope, the projection of the slope to a horizontal plane;

trend, the trend of the shortest distance from the upper point of the slope to its foot, along this trend, the steepness of the slope is greatest;

bend in the slope, the line of sudden change in the steepness of the slope from the steeper to the gentler or vice versa.

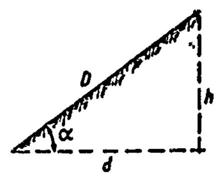


Figure 13. Elements of slope D.

α - steepness of slope; h - height of slope; d - horizontal projection of slope.

СКАТ ВОГНУТЫЙ
SKAT VOGNUTYY

Concave slope. A slope, the steepness of which is reduced toward the foot; on a map, it is represented by contour lines the distance between which is increased down slope (fig. 14). A concave slope can be observed completely and fired through completely.

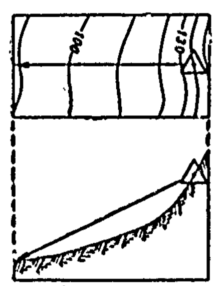


Figure 14. Concave slope.

СКАТ ВОЛНИСТЫЙ
SKAT VOLNISTYY

Wavy slope (mixed). Represents a combination of concave, convex, and smooth slopes (see).

СКАТ ВСТРЕЧНЫЙ
SKAT VSTRECHNYY

Meeting slope. A slope within the enemy's dispositions which drops in the direction of own troops.

СКАТ ВЫПУКЛЫЙ
SKAT VYPUKLYY

Convex slope. A slope the steepness of which increases toward the foot; on maps, it is shown by contour lines, the distances between which are

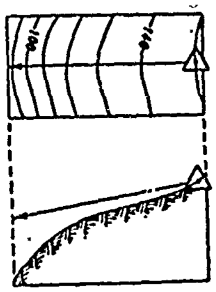


Figure 15. Convex slope.

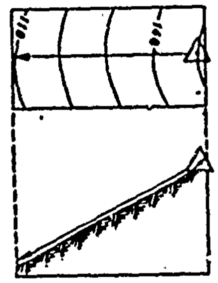


Figure 16. Smooth slope.

reduced down slope (fig. 15). A concave [sic] slope is observed and fired through by flat trajectory fire only up to the bend in the slope.

СКАТ ОБРАТНЫЙ
SKAT OBRATNYY

Reverse slope. A slope which drops toward the rear of friendly troops.

СКАТ ПЕРЕДНИЙ
SKAT PEREDNIY

Forward slope. A slope which drops in the direction of the enemy.

СКАТ РОВНЫЙ
SKAT ROVNYY

Smooth (straight) slope. A slope, the steepness of which is the same over its entire length; on maps, it is represented by contour lines, the distances between which are equal (fig. 16).

СКЛОНЕНИЕ МАГНИТНОЙ СТРЕЛКИ
SKLONENIYE MAGNITNOY STRELKI

Declination of the magnetic needle. The angle between the geographic meridian and the line of direction of the magnetic needle (magnetic meridian). The amount of declination of a magnetic needle is subjected to long-time and daily fluctuations as well as to temporary disturbances under the influence of magnetic storms. With a declination of the magnetic needle to the east, the declination is considered eastern (+ sign) and with a declination to the west - western (- sign). The declination of a magnetic needle and its annual changes are shown on topographic and special maps. The declination of a magnetic needle fluctuates sharply in regions of magnetic anomalies.

СКОРОСТЬ ТЕЧЕНИЯ РЕКИ
SKOROST' TECHENIYA REKI

Speed of river current. One of the basic characteristics of rivers (Table 16).

Table 16

Nature of current	Speed of current, meters/second	
	Flatland rivers	Mountain rivers
Weak	Up to 0.5	Up to 2.0
Average	0.5 - 1.0	2.0 - 4.0
Rapid	1.0 - 2.0	4.0 - 6.0
Extremely rapid	Above 2.0	Above 6.0

СНЕГОВАЯ ЛИНИЯ
SNEGOVAYA LINIYA

Snow line. The lower limit of the zone of permament snow in the mountains. The altitude of the snow line depends on the geographic latitude of the point, proximity of warm ocean currents, and several other causes (see Mountain terrain).

СОКРАЩЕННЫЕ КООРДИНАТЫ
SOKRASHCHENNYYE KOORDINATY

Abbreviated coordinates. The arbitrary abbreviation of rectangular coordinates in target indication on a topographic map where only the tens and units of kilometers and meters are called (recorded). For example: x = 62,700, y = 14,550, which means x = 62 km 700 meters, y = 14 km 550 meters. Abbreviated coordinates are used for brevity in recording (transmitting) coordinates. It is not recommended that abbreviated coordinates be used in operations at the junction of zones since this may lead to confusing targets disposed in different zones and to coarse errors.

СРЕДИННАЯ ОШИБКА
SREDINNAYA OSHIBKA

Median error. One of the criteria for evaluating precision of measurements. The size of the median error in absolute value is greater than any of the errors of one half the errors of a given series of measurements and less than each error in the other half of the errors, disposed in ascending order.

The median error equals approximately 0.7 of the mean square error [srednyaya kvadraticheskaya oshibka] (see).

СРЕДНЯЯ КВАДРАТИЧЕСКАЯ ОШИБКА
SREDNYAYA KVADRATICHESKAYA OSHIBKA

Mean square error. The primary criterion in evaluating precision of measurements. The mean square error equals the square root of the sum of the squares of the errors of a given series of measurements divided by the number of measurements.

СРЕДНЯЯ ОШИБКА
SREDNYAYA OSHIBKA

Mean error. A criterion for evaluating the precision of measurements. The mean error equals the sum of the absolute values of the sizes of individual errors obtained during measurements divided by the number of measurements. The mean error is approximately equal to 0.8 of the mean square error (see).

СТВОР
STVOR

Line of direction. A vertical plane which passes through two points on the terrain. To be in the line of direction means to be at some third point which is located in the designated plane.

СТЕПЬ
STEP'

Steppe. A natural zone of the temperate belt with a dry continental climate and the predominance of drought-resistant grassy vegetation (mixed grasses, grains, feather grass-fescue).

СТЕРЕОПАРА
STEREOPARA

Stereopair. Two photos of the same terrain obtained from two photo points. The simultaneous examination of the stereopair, with the corresponding placement of the photos separately, with two eyes (left photo, left eye; and right photo, right eye) provides a stereoscopic (three-dimensional) effect.

The stereopair is examined by means of a stereoscope (see) or other stereoscopic instruments.

СТЕРЕОСКОП
STEREOSKOP

Stereoscope. An instrument which permits obtaining a three-dimensional image of a photographed object (terrain, trench, tank, etc.) from two photos

which comprise a stereopair (see). The stereoscope assures the separation of the vision of the left and right eyes, as well as magnification of the photographic image. For the interpretation of aerial photos, lens-mirror stereoscopes are usually used, one of the varieties of which is shown in figure 17. (For the use of a stereoscope, see Section 8, Chapter IV).

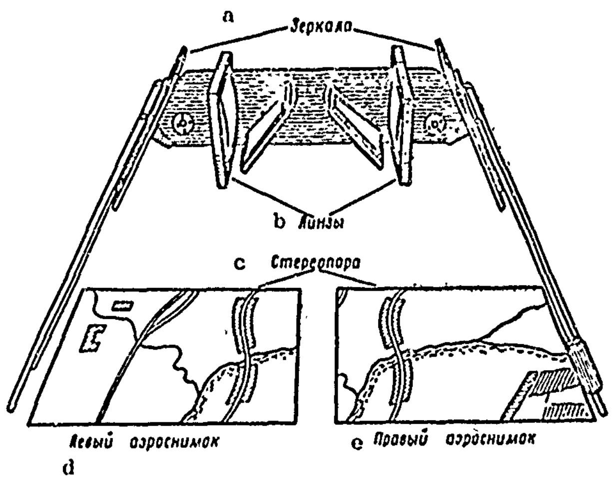


Figure 17. Lens-mirror stereoscope.

a - mirrors; b - lenses; c - stereopair; d - left aerial photo; e - right aerial photo.

СТОРОНЫ ГОРИЗОНТА
STORONY GORIZONTA

Directions of the compass. The basic directions used for orientation on the earth's surface. The chief ones are north, south, east, and west. The N - S direction, direction of the meridian, is taken as the initial direction; the E - W direction is perpendicular to it.

СТРЕЖЕНЬ
STREZHEN'

Deep channel in a river. The line of greatest speed of current of a river which, as a rule, coincides with the position of the greatest depths (see Waterway [farvater]).

СУГЛИНОК
SUGLINOK

Loam. A fine-grained loose soil which contains 12 - 25% clay particles. With respect to difficulty to work, it belongs to the average group; it gets soaked in rainy weather.

СУМЕРКИ
SUMERKI

Twilight.

1. Astronomic twilight, the interval of time from the setting of the sun to the moment that it drops 18° below the plane of the horizon and, correspondingly, prior to sunrise. In the first case, it is evening twilight, in the second - morning twilight.

2. Civilian twilight, the interval of time after sunset as well as before sunrise when illumination permits reading in the open air without artificial illumination, distance objects can be clearly seen, and orientation and target indication on the ground are possible with the same procedures as during the day. In duration, civilian twilight is approximately 7/18 astronomic twilight.

СУПЕСЬ (супесок)
SUPES' (Supesok)

Sandy loam. A fine-grained loose soil containing 3 - 12% clay particles. In difficulty to work, it belongs to the group of easy soils and possesses extremely good road qualitites in any weather.

СХЕМА МЕСТНОСТИ
SKHEMA MESTNOSTI

Terrain sketch. A simplified sketch of a terrain sector which is prepared from a map, aerial photo, or directly on the ground (for conventional signs which are used in preparing terrain sketches, see Section 9, Chapter IX).

ТАЙГА
TAIGA

Taiga. A region of virgin pine forests of the temperate belt. The taiga is difficult to negotiate due to the abundance of wind-fallen wood, slash fires, and swampy sectors.

ТАКТИЧЕСКИЕ СВОЙСТВА МЕСТНОСТИ
TAKTICHESKIYE SVOYSTVA MESTNOSTI

Tactical properties of the terrain. Properties of the terrain which have a significant effect on the conduct of combat operations by troops. The basic tactical properties of the terrain usually include conditions for protection against weapons of mass destruction, trafficability conditions, and conditions for camouflage and observation. In desert terrain, a considerable influence on the actions of the troops is had by conditions for water supply and orientation.

ТАКЫРЫ
TAKYRY

Takyr soils. Clayey sectors in deserts and semideserts with a smooth, cracked surface in the dry period and sticky mud after rains. Takyr soils are shown on topographic maps.

ТЕРРАСЫ
TERRASY

Terraces. Forms of slopes of the relief in the form of horizontal or slightly inclined steps.

ТЕРРИКОН
TERRIKON

Waste pile. A cone-shaped dump of rock at a shaft or mine.

ТЕСНИНА
TESNINA

Defile. A narrow pass with very steep or perpendicular slopes, often completely occupied by a river channel.

ТИПОВЫЕ ФОРМЫ РЕЛЬЕФА
TIPOVYYE FORMY REL'YEFA

Typical relief forms. See Relief.

ТОПОГЕОДЕЗИЧЕСКАЯ ПОДГОТОВКА
TOPOGEODEZICHESKAYA PODGOTOVKA

Geodetic survey. A part of the geodetic support of the combat activities of troops. It includes:

the creation of the initial base for the survey tie-in;

the survey tie-in [topogeodezicheskaya privyazka] (see) of positions, posts, points.

The initial base for the survey tie-in is provided by the geodetic control net (see), topographic maps, and aerial photos (photomaps).

ТОПОГЕОДЕЗИЧЕСКАЯ ПРИВЯЗКА
TOPOGEODEZICHESKAYA PRIVYAZKA

Geodetic survey tie-in (of positions, posts, points). A part of the geodetic survey. It includes:

determination of the rectangular plane coordinates x, y, and altitude H of the points being tied in;

determination of the grid azimuths of reference lines of directions which are necessary for the laying of rockets, launchers, guns, and instruments in an assigned direction.

The geodetic survey tie-in may be performed on a geodetic basis and from a map (aerial photo).

In the geodetic survey tie-in on a geodetic basis, the coordinates x and y of the points being tied in are determined with the use of instruments relative to points of the geodetic control net (see). Grid azimuths of reference lines of direction are determined from lines of direction of the geodetic control net (geodetic method), as well as by astronomic and gyroscopic methods. The altitude H of a point which is being tied in is determined from a map.

In the survey tie-in from a map (aerial photo), the coordinates of the points being tied in are determined by means of an odograph (see [topoprivyazchik]) or instruments relative to map points of a map (aerial photo) of a scale no smaller than 1:100,000. Grid azimuths of reference lines of direction are determined primarily by gyrocompass, less often by the PAB aiming circle, from heavenly bodies, and by other methods. The altitude H of the points being tied in is read from a topographic map.

ТОПОГЕОДЕЗИЧЕСКОЕ ОБЕСПЕЧЕНИЕ
TOPOGEODEZICHESKOYE OBESPECHENIYE

Geodetic survey support. A type of support of combat actions of troops, the essence of which consists of the preparation and delivery to the troops of topographic and geodetic data on the terrain and the earth (terrestrial sphere) which are necessary in planning, organizing, and conducting combat actions.

The primary missions of geodetic survey support are:

the creation (updating) of topographic and special maps and their timely supply to the troops;

the development (intensification) of geodetic nets and supplying the troops with lists of the coordinates of geodetic points and gravimetric data necessary for effective employment of rocket weapons.

The development of geodetic nets and creation of maps are achieved by the execution of long and extremely complex scientific-technical work which is accomplished ahead of time and in the course of the war, primarily by organs of the Military Topographic Service and special chast' (podrazdeleniye).

ТОПОГРАФИЧЕСКАЯ РАЗВЕДКА
TOPOGRAFICHESKAYA RAZVEDKA

Topographic reconnaissance. The collection and systematization of data on the terrain which is accomplished by its direct investigation, from aerial photos, reports, and other materials with the purpose of creating control nets, supplementing and correcting maps, and creating special maps, descriptions, and information about the terrain.

ТОПОГРАФИЧЕСКИЕ ДАННЫЕ
TOPOGRAFICHESKIYE DANNYYE

Topographic data. Data concerning the terrain, its relief, and local objects and about its location, dimensions, configuration, etc. Topographic maps and aerial photos serve as the most important source for obtaining topographic data.

ТОПОГРАФИЧЕСКИЕ КАРТЫ
TOPOGRAFICHESKIYE KARTY

Topographic maps. See [Karty topograficheskiye].

ТОПОГРАФИЧЕСКИЕ УСЛОВНЫЕ ЗНАКИ
TOPOGRAFICHESKIYE USLOVNYYE ZNAKI

Topographic conventional signs. A system of graphical, numerical, and textual designations which are used in combination with coloring to represent the terrain on topographic maps. The following topographic conventional signs are distinguished: scale (expressing terrain elements at the scale of a given map), off-scale (showing a local object without conveying its boundaries), and explanatory (showing the direction and speed of current of a river, number of yeards, type of production, etc.). In the USSR, a system of topographic conventional signs has been adopted which is common for all departments.

ТОПОГРАФИЧЕСКИЕ ЭЛЕМЕНТЫ МЕСТНОСТИ
TOPOGRAFICHESKIYE ELEMENTY MESTNOSTI

Topographic terrain elements. The relief, soil-ground, and plant cover, water objects (hydrography), populated places, road net; industrial, agricultural and socio-cultural objects.

ТОПОГРАФИЧЕСКИЙ ГРЕБЕНЬ
TOPOGRAFICHESKIY GREBEN'

Topographic crest. See Watershed.

ТОПОГРАФИЯ
TOPOGRAFIYA

Topography. See Geodesy.

ТОПОПРИВЯЗЧИК
TOPOPRIVYAZCHIK

Odograph. A wheeled or tracked vehicle equipped with instruments for the automatic determination of the coordinates of points on the terrain and used for the tie-in of elements of a combat formation of missile troops and artillery.

ТОЧНОСТЬ ТОПОГРАФИЧЕСКИХ КАРТ
TOCHNOST' TOPOGRAFICHESKIKH KART

Accuracy of topographic maps. One of the basic characteristics of topographic maps. It depends on many factors (geodetic base of the map, method of preparing the map, distortion of the paper, etc.) and is characterized by errors in the position of terrain elements on the map. According to existing standards, the average error in the position, on the map, of objects and terrain points relative to the nearest points of a plane survey net should not exceed 0.5 mm and in mountain, high mountain, and desert regions 0.75 mm at the scale of the map; mean errors in the position of contour lines should not exceed 0.4 h in flat and hilly terrain (h is the contour interval of the given map) and, on maps of mountain regions, h.

In determining the position of targets and other objects on a map as well as in the initial orientation of navigation equipment and in other cases, several special features of topographic maps should be considered:

in depicting populated places, the only items plotted accurately are their outer shape, main thoroughfares, and structures nearest to intersections; the number of structures usually does not reflect their actual number but only characterizes the building density; therefore, the building within blocks should not be used in precise measurements;

with the dense disposition of homogeneous terrain objects (buildings, wells, mounds, etc.) which are concentrated on a small area, only the extreme items are shown with preservation of their exact position;

the center between two lines which represent roads corresponds to the middle of the roads on the terrain, while the lines of the conventional signs themselves do not correspond to the edges of the road in the majority of cases;

terrain objects which are not expressed at the scale of the map (geodetic point, lone tree, etc.) are portrayed in a magnified form and their exact position on the map is determined by the main point (line) of the conventional sign (see Appendix 2, page 258).

ТРИАНГУЛЯЦИЯ
TRIANGULYATSIYA

Triangulation. A method of determining the position of geodetic points. Markers are set up on elevated places (signals, pyramids, and others) in such a way that there is intervisibility between adjacent markers and a network of triangles is formed. In each triangle, all angles are measured with great precision and, in one of the triangles, one of the sides (base) and azimuth are measured with great precision; from these data, all sides of the triangles, grid azimuths from point to point, and the coordinates of the points are computed.

ТРИГОНОМЕТРИЧЕСКИЙ ПУНКТ
TRIGONOMETRICHESKIY PUNKT

Trigonometric point. See Geodetic point.

ТРОПЫ
TROPY

Paths. Trails for pedestrians and pack animals. Paths are shown on topographic maps only in areas which are difficult to negotiate: in mountains, deserts, heavily swampy places.

ТУНДРА
TUNDRA

Tundra. Terrain in areas of higher latitudes with a sparse brushy-grassy or moss-lichen vegetation. Typical of the tundra are a long severe winter, short cold summer (maximum temperature 10 - 12°), a small amount of precipitation, great cloudiness, strong winds (particularly in winter), and frozen ground which only thaws at the top in summer. Tundras are comparatively difficult to negotiate, particularly in the warm part of the year.

УВАЛ
UVAL

Rounded, low ridge. An elevation which is extended in one direction with comparatively low height (up to 200 meters), with gentle slopes which gradually transform into a plain. In military practice, terrain which abounds with low, rounded ridges is called hilly, and the individual rounded, low ridges are called hills.

УГОЛ МЕСТА ЦЕЛИ
UGOL MESTA TSELI

Angle of site to the target. The angle between the gun and target line of direction and the horizontal at the muzzle. The angle of site to the target is calculated from the formula

$$\epsilon = 1000 \cdot B/D$$

where

ϵ is the angle of site to the target in mils;

B is the height of the target above (below) the gun position (determined from a map);

D is the distance (range) from the gun position to the target.

УГОЛ УКРЫТИЯ
UGOL UKRYTIYA

Angle of clearance. The angle formed by the horizontal at the muzzle and the line of direction to the summit (crest) of the defilade. An angle of clearance up to 300 mils is calculated from the approximate formula

$$\alpha = 1000 \cdot B/D,$$

where

α is the angle of clearance in mils;

B is the height of the defilade relative to the horizontal at the muzzle;

D is the gun - defilade range.

УКАЗАТЕЛЬ СКАТА
UKAZATEL' SKATA

Slope indicator (incline indicator, hachure). A conventional symbol for indicating the direction of descent of slopes in depicting the relief with contour lines. These are lines (hachures) perpendicular to the contour lines with their free end indicating the direction of the slope (descent).

УЛУЧШЕННАЯ ГРУНТОВАЯ ДОРОГА
ULUCHSHENNAYA GRUNTOVAYA DOROGA

Improved dirt road. A graded dirt road on a natural foundation, the roadway of which is often improved by the addition of gravel, crushed rock, or sand. As a rule, the width of the road permits two-way traffic. Longitudinal inclines are up to 7°.

УРЕЗ ВОДЫ
UREZ VODY

Water's edge. The reading (value) of the absolute altitude of the water level in a river (lake) at low water level (see).

УРОВЕННАЯ ПОВЕРХНОСТЬ
UROVENNAYA POVERKHNOST'

Water-level surface. An imaginary surface of the mean level of the ocean which is continued beneath the continent.

УСОВЕРШЕНСТВОВАННОЕ ШОССЕ
USOVERSHENSTVOVANNOYE SHOSSE

Improved highway. A road on a substantial foundation with a surface of asphalt, cement, concrete, and sometimes of blocks, bricks, crushed stone,

and gravel impregnated with a binding substance. The width of the roadway is at least 7 meters, and slopes are up to 5°. In many cases, gasoline stations and vehicle repair shops are found alongside the highway.

ФАРВАТЕР
FARVATER

Waterway, channel. A stretch of a river with greatest depths, devoid of obstacles, along which ships usually sail (see Channel).

ФОРМУЛА ТЫСЯЧНЫХ
FORMULA TYSYACHNYKH

Mil relation

$$D = 1000 \cdot B/Y; \quad B = D \cdot Y/1000,$$

where

D is the range to the object;

B is the height (width) of the object;

Y is the angle in mils.

The mil relation is widely used by the troops for determining distances (range or height) from the angular dimensions of the object measured in mils; it provides sufficiently accurate results with a value of Y within limits of 300 mils (18°).

ФОТОГРАММЕТРИЯ
FOTOGRAMMETRIYA

Photogrammetry. A technical discipline which considers the geometric properties of a photographic image and methods of measurement from an aerial photo in creating maps, determining target coordinates, etc.

ФОТОКАРТА
FOTOKARTA

Photographic chart. A photographic document which combines a plane photo image of the terrain and data placed on a map (relief, represented contour lines, names of populated places, etc.).

ФОТОПЛАН
FOTOPLAN

Photomap. A measurement photo document and, with the plotting of data about the enemy on it, a reconnaissance photo document assembled from photos which have been strictly reduced to one scale (rectified). A coordinate grid is plotted on a photomap and the names of populated places, rivers, terrain features, and altitude readings are printed. Important local objects which are difficult to read on photo images are highlighted by the corresponding conventional signs.

ФОТОСХЕМА
FOTOSHKEMA

Uncontrolled mosaic. A group of aerial photos assembled (matched) by common terrain points and glued together into one whole; it is used for making an estimate of the enemy and the terrain.

ХАРАКТЕРНЫЕ ТОЧКИ И ЛИНИИ РЕЛЬЕФА
KHARAKTERNYYE TOCHKI I LINII REL'YEFA

Characteristic points and lines of the relief. Summits (of a mountain or hill), the bottom (of a depression), line of a watershed (see), line of runoff (see), saddle (see).

ХОЛМ
KHOLM

Hill. A height (small mountain) up to 200 meters high above the foot.

ХОЛМИСТЫЙ РЕЛЬЕФ
KHOLMISTYY REL'YEF

Hilly relief. A type of relief with the predominance of hills. Relative altitude differences are from 25 to 200 meters in 2 km; the predominant steepness of slopes is 2 - 3°.

ХОРДОУГЛОМЕР
KHORDOUGLOMER

Chord and angle measurer. An instrument for measuring and constructing angles on a map (fire plotting board) in mils and widely used in the artillery. (For the technique of measuring and constructing angles using the chord and angle measurer, see Section 2, Chapter III).

ХРЕБЕТ
KHREBET

Ridge. An elevation which is extended in some direction.

ЦЕЛЕУКАЗАНИЕ
TSELEUKAZANIYE

Target indication. The indication of a target's location which is brief but sufficiently accurate for the accomplishment of the assigned mission. Target indication may be performed directly on the ground or from a topographic map, aerial photo, or mosaic (for greater detail, see Chapter VI).

ЦЕНА ДЕЛЕНИЯ
TSENA DELENIYA

Value of a division. The value (angular, linear) of the smallest division of a measurement instrument (compass, aiming circle, theodolite, slide rule, etc.).

ЦЕНТРАЛЬНАЯ ПРОЕКЦИЯ
TSENTRALNAYA PROYEKTSIYA

Central projection. A method of projecting (transferring) a projected figure (body) on to a plane by rays which pass through one point - the center of the projection.

ЦИРКУЛЬ ПРОПОРЦИОНАЛЬНЫЙ
TSIRKUL' PROPORTSIONAL'NYY

Proportional dividers. An instrument for measuring segments on a map (aerial photo) with their simultaneous (mechanical) magnification (reduction) the required number of times (fig. 18); it is used to transfer objects from an aerial photo to a map and to prepare copies or diagrams at a scale which is increased or decreased (in comparison with the original).

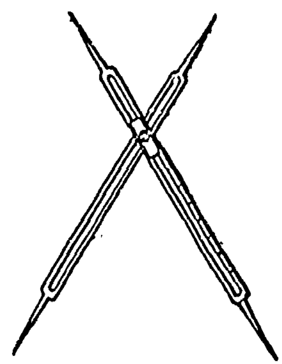


Figure 18. Proportional dividers.

ШКАЛА ЗАЛОЖЕНИЙ
SHKALA ZALOZHENIY

Vertical profile scale. A gr ph for determining the steepness of slopes from topographic maps; it is located in the southern margin of the map sheet. (For the construction and rules of use, see Section 3, Chapter II).

ШЛЮЗ
SHLYUZ

Sluice. A hydraulic structure on a river or canal which is intended to assure navigation with sudden drops in the level of the water. The basic elements of the sluice are: the dam (to raise the water in the river) and the sluice chambers (for the passage of the vessels).

ШОССЕ
SHOSSE

Highway. 1. The general designation of automobile roads with a hard surface. 2. Roads with a surface of cobblestone and split rock (pavements), or of gravel, slag, or crushed stone, packed by rolling, often impregnated with a binder, sometimes asphalted, and permitting automobile traffic for the entire year. In contrast to roads of a higher class (superhighways, improved highways), they have a less substantial foundation, in which connection they are subject to rapid destruction or intensive maintenance. Upgrades and downgrades are sometimes greater than 5°. In military practice, this type of highway is often called a "regular highway." On topographic maps, they are shown by a special conventional sign. The elements of a transverse profile of a highway are shown in Figure 19.

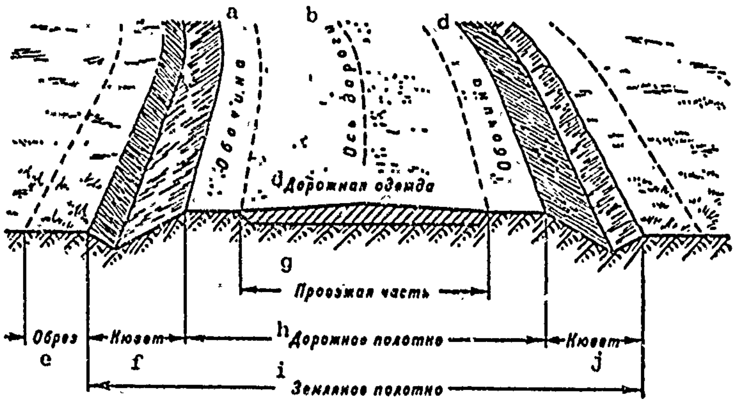


Figure 19. Elements of the transverse profile of a highway.

a - shoulder; b - road center line; c - shoulder; d - road surfacing; e - edge; f - drainage ditch; g - roadway; h - roadbed; i - subgrade; j - ditch.

ЭКВАТОР ЗЕМНОЙ
EKVATOR ZEMNOY

Earth's equator. A great circle of the earth's sphere equidistant from the poles and dividing the earth's sphere into the northern and southern hemispheres.

ЭКВАТОР НЕБЕСНЫЙ
EKVATOR NEBESNYY

Celestial equator. A great circle of the celestial sphere, all points of which stand 90° from the poles of the world. The plane of the celestial equator is parallel to the plane of the earth's equator and is perpendicular to the earth's axis.

ЭКЛИМЕТР
EKLIMETR

Clinometer. An instrument for measuring angles of incline on the ground.

ЭЛЛИПСОИД
ELLIPSOID

Ellipsoid. A body which is formed by the rotation of an ellipse around its small axis.

ЭПИЦЕНТР
EPITSENTER

Epicenter. The projection, on the earth's surface, of the center of an earthquake, nuclear air burst, etc.

Chapter II

Selecting, Obtaining, and Preparing Topographic Maps for Work

1. Selection of Maps

a) Selection of topographic map scales

In selecting the scale of a topographic map, consideration is given to the availability of maps, nature of impending operations, purpose of the maps (for podrazdeleniye, chast', or soyedineniye, for studying the terrain, orientation, etc.) and the nature of the terrain.

Preference should be given to larger scale maps when conducting defensive operations, forcing water obstacles, for combat operations in large populated places and densely populated areas, or where it is necessary to reflect the combat situation in the greatest possible detail on a work map.

Smaller scale maps should be used in mobile forms of combat, as well as in organizing a march. For orientation in movement, it is more preferable to have a 1:100,000 scale map, but under difficult orientation conditions (in forest-swamp, mountain, or densely populated terrain(, it is expedient to use a 1:50,000 map, and in accomplishing a march over long distances over highways or in desert or desert-steppe terrain, a 1:200,000 scale map.

In selecting a map, particularly for evaluating the terrain and orientation, attention should be paid to its timeliness (reliability) and preference should be given to the latest map, i.e., more recent in content.

b) Determining map nomenclature

Nomenclature of map sheets for a given area is usually determined from a special map index (map indices are published by the Military Topographic Service). The nomenclature of map sheets can also be determined from geographic coordinates of some point of a given area or from the nomenclature of adjacent map sheets (see Map Nomenclature of the USSR, Chapter I).

The nomenclature is determined from the map index by the procedure shown in the next example.

Example. It is required to prepare a requisition for 1:100,000 and 1:500,000 scale maps for the route Nizhne-Kolymsk and Labaznoye along the Great Anyuy River (fig. 20).

We note the required sheets in the map index and record their nomenclature in succession:

1:100,000	1:500,000
R - 57 - 131, 143, 144;	R - 57 - G;
Q - 57 - 12;	Q - 57 - B;
Q - 58 - 1, 13, 25, 37, 38, 39;	Q - 58 - A.

Nomenclature of map sheets is determined frò geographic coordinates of the area of interest with the use of numbering diagrams (fig. 21 - 25) in the absence of a map index.

Example. It is required to determine the nomenclature of a map sheet with a scale of 1:100,000 for the area of the city of Bobruysk.

We determine the geographic coordinates of Bobruysk from any geographic map (φ = 53°10', λ = 29°15'); from them, on the nunbering diagram of maps drawn at a scale of 1:1,000,000 (see fig. 21) we find the position of Bobruysk and establish the nomenclature of the corresponding sheet of the 1:1,000,000 map (N-35).

We write down (lightly, with aplain pencil) the latitude and longitude of the borders of sheet N-35 (φ = 52° and 56°, λ = 24° and 30°) on the numbering diagram of 1:100,000 scale maps (see fig. 24), and determine the location of the city of Bobruysk (φ = 53°10', λ = 29°15') from geographic coordinates on the diagram. We determine the number of a 1:100,000 map sheet; in this case, is is sheet 107, and the nomenclature of the 1:100,000 map sheet for the area of Bobruysk is N - 35 - 107.

If it had been required to determine the nomenclature of map sheets of 1:50,000 or 1:25,000 scales, then, after determining the nomenclature of the 1:100,000 map sheet it would have been necessary to turn to the numbering diagram of this sheet for map sheets of scales of 1:50,000 and 1:25,000 (see fig. 25). In this, the procedure of operation is similar to what has been presented; the coordinates of the borders of map sheets of 1:100,000 are written down and then, from the coordinates, the required sheets and their nomenclature are determined.

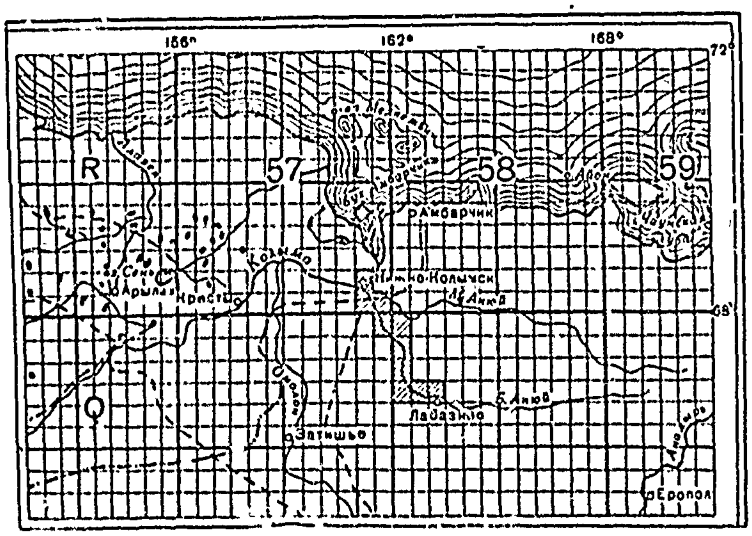


Figure 20. Index map.

Left of 156°, top to bottom: Alazeya; Lake Sen; Arylakh; left of 162°, top to bottom: Medveshyi Islands; Ambarchuk Bay, Kolyman; Kresty; Omolon; Zatishya; left of 168°: Ayon Island; Ambarchuk; Nizhne-Kolymsk; Small Anyuy; Great Anyuy; Labaznoye; right of 168°: Chaunskay Bay; Anadyr; Yeropol.

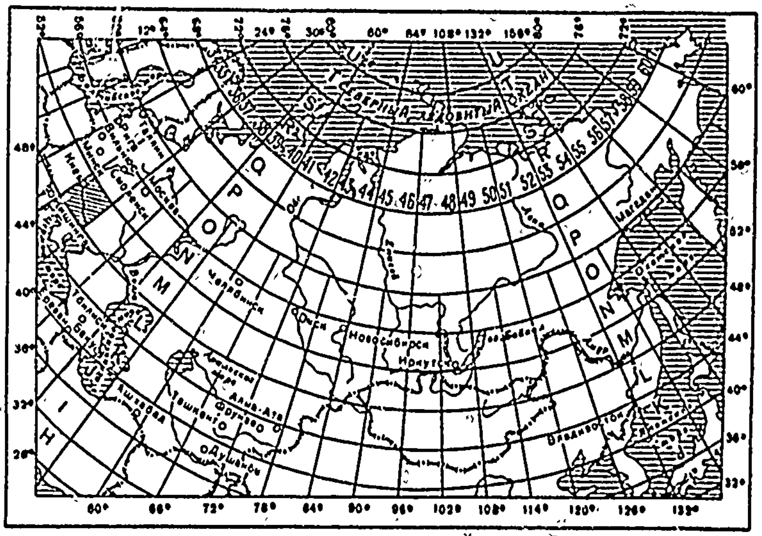


Figure 21. Numbering diagram and nomenclatures of 1:1,000,000 map sheets for the territory of the USSR.

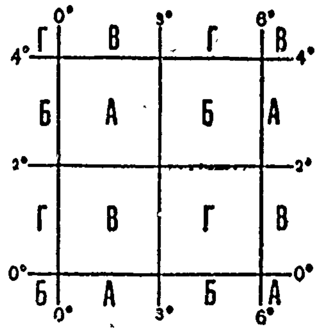


Figure 22. Numbering 1:1,000,000 map sheet for 1:500,000 map sheets.

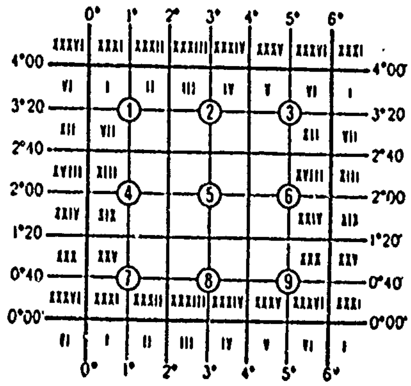


Figure 23. Numbering a 1:1,000,000 map sheet for 1:200,000 map sheets.

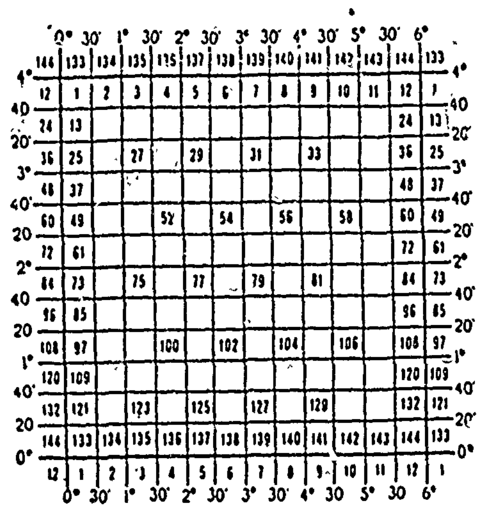


Figure 24. Numbering a 1:1,000,000 map sheet for 1:100,000 map sheets.

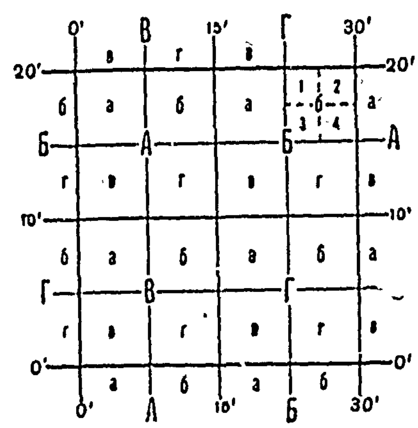


Figure 25. Numbering a 1:1,000,000 map sheet for 1:50,000, 1:25,000, and 1:10,000 map sheets.

Figure 26. Designation of the nomenclature of an adjacent sheet in the marg'n of a map.

With the availability of a map sheet, or the pasting together of sheets, the nomenclature of adjacent (adjoining) sheets may be determined from the legend on the sides of the border of the sheet from the corresponding side (the legend indicates which sheet is located here, see Fig. 26) or with the use of the numbering diagram of the corresponding scale. In the latter case, the disposition of available sheets is determined and marked on the diagram, after which a determination is made of the nomenclature of the necessary adjacent sheets in the normal manner as well as from the map index.

2. Obtaining Maps

a) General rules for supplying maps

The function of supplying maps in the chast' and institutions which do not have organs of the Topographic Service are performed by specially designated persons.

The number of maps issued is determined by supply norms in effect. Inclusion on the distribution list for topographic maps is accomplished as follows. Newly formed chast', on the basis of the order of formation, transferred chast', on the basis of a certificate issued and verified by the formed supply organ. With the first receipt of map, presented together with the certificate is the nomenclature information of the maps which are charged to the chast'. On leaving, the chast' turns in the unneeded maps, accounts for those expended, and receives a certificate.

The issuing of maps is performed on the basis of requisitions compiled in accordance with an established form (Table 17). Maps may be passed from chast' to chast' with permission of the chief of the Topographic Service of the district (soyedineniye).

The shipment (forwarding) of maps is performed by special transport, express, liaison officers, through report collection points, and, with a small quantity (up to 8 kg), through field communication organs. When the recipient discovers a shortage of maps, he prepares a report and sends one copy of the map to the shipper.

Personnel keep a record of the availability and movement of maps, as well as a record of the issue of maps by means of special books.

Each map sheet issued for work is marked on the back in accordance with the following form:

Troop chast' No. ______________
From issue book No. ______________
"____" ______________ 196____

Maps with plotted situations, with the increase in their security classification, as well as when it is necessary to store them or dispatch them as documents, are recorded in the corresponding registers, registers of incoming and outgoing documents. The maps are dropped from accountability in the Issue Book on the basis of information from the department which keeps the topographic maps.

Maps which have become unserviceable are destroyed in accordance with a statement in the headquarters of the chast' (institution) by a specially established commission. It is prohibited to destroy maps in the podrazdeleniye.

The exact number of sheets required are glued together for work; it is prohibited to paste more sheets together just to even out the sheets, etc.

Rules for filling requisitions. The requisition is prepared by scales, beginning with the largest and with the successive transition to the smaller. Nomenclatures are written down in increasing order, in which respect only new (chainging) nomenclature markings are written, as shown in the sample. The number and year of publication are indicated in the case where the maps are already on hand and it is desirable to receive maps of the same edition. It is mandatory to fill in the column "on hand". The required quantity is put down for each nomenclature. The totals are summed up for each sacle and for the entire requisition.

b) Requisition for topographic maps

Table 17

Requisition form

Scale, nomenclature	Classification	No. and year of publication	Number of sheets			Remarks
			On hand	Required	Released	
1:25,000						
N - 35 - 11 - V - v	Unclassified	2-1960	10	90		
g	"	3-1965	10	90		
G - a	"	3-1965	None	100		
b	"	3-1965	None	100		
Total			20	380		

3. Preparation of Maps for Work

Preparation of maps for work includes:

map evaluation (Table 18);

pasting map sheets together;

folding the map;

marking the terrain elements on the map (map marking).

a) Map evaluation

Table 18

Order and content of map evaluation

Subject of evaluation	Purpose of evaluation	Content and methods of evaluation
Scale	Evaluate completeness and precision of map, obtain initial data for determining distances from the map.	1. Determine scale from legend at bottom of map sheet. 2. Clarify what 1 cm (1 mm) on the map corresponds to on the ground, the dimensions of the side of the square of the kilometer grid in centimeters and to what it corresponds on the ground (in m, km). 3. Evaluate the dimensions of several basic, most prominent objects on the map by means of comparison with which one may be able to estimate distances visually in the process of subsequent work on the map.
Contour interval.	To obtain data to determine absolute altitude of points and steepnesses of slopes as well as to evaluate the completeness of representation of relief.	1. The contour interval is determined from the legend beneath the southern margin (beneath the scale) or from two altitude readings on one slope and the number of contour lines between them. 2. To clarify what steepness of slope corresponds to the horizontal projection of contour lines per cm or mm.
Year of survey and reconnaissance	To determine the degree of contemporaneousness and reliability of the map.	1. The year of survey and reconnaissance is determined from the legend in the southeastern corner of the sheet. 2. To clarify the correspondence of the map to the terrain.
Number and year of publication (indicated in all cases when referring to map).	To assure unity of orientation and target indication.	1. Number and year of publication are established from legend in northwest corner of margin or from legend beneath the nomenclature of a given map. 2. To clarify possible changes in conventional signs and appearance of maps during the period from moment of publication of map.

(Table 18 cont.)

Direction correction	To determine the amount of direction correction for changing from grid azimuths to magnetic azimuths and vice versa.	The amount and sign of the correction are established from the diagram or textual reference located in the southwestern corner of the sheet.

b) Pasting map sheets together

In pasting together a large number of sheets, first a diagram of the disposition of the sheets is prepared, or the area covered by the sheets is outlined on the map index. In accordance with the diagram or the preliminary distribution, the contiguous sheets are cut along the eastern and southern margins. The cutting is performed with a sharp knife (cutting edge of a razor, scissors) exactly along the inner margin of the sheet; it is better to cut with a knife without using a ruler. To avoid gaps in the paper, it is recommended that cutting with a knife be done on a smooth wooden (unpainted) board or on a cardboard backing. The cutting edge of the knife (razor) should be held at a sharp angle (with the slope in the direction of the line of cut).

The sheets are pasted together in rows or columns first in the direction where the pasting is shorter.

When pasting, the cut sheet (row, column) is placed with its reverse side on the adjacent uncut sheet and, bringing them up to the pasting line, a thin uniform layer of glue is applied to the pasting strip by brush (rag, paper). Then the upper sheet is turned over, and the sheet margins are matched as are the kilometer lines and corresponding contours. The pasted place is wiped with a dry rag (paper), making a motion across the line of pasting in the direction of the cut. Small nonconformances may be corrected by rubbing in a direction opposite to the direction of distortion.

With different deformation of two adjacent sheets (one longer than the other along the margin), the shorter sheet is coated with glue which permits stretching it somewhat and making it even with the longer sheet.

For the best storage of the maps, as well as for convenience in use, it is recommended that not more than 9 to 12 sheets be included in one pasting. For a larger number of sheets, 2 to 3 pastings (or more) are made which, with the availability of a place and the necessity for their prolonged use, are matched temporarily along common margins (turned under ahead of time).

c) Folding the map

Folding the map is done for the purpose of providing convenience in working with it (particularly under field conditions) and its better storage.

Most often, the maps are folded with maintenance of orientation with respect to the directions of the compass. If the area of operations represents an elongated strip, then for work under field conditions it is recommended that the map be folded along the strip of impending troop operations. Unneeded parts of the map are bent downward in this, and then the map is folded "like a bellows" in accordance with the dimensions of the plotting board or case in which it will be kept (fig. 27).

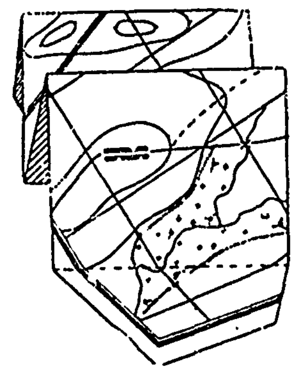


Figure 27. Folding a map.

For orientation and target indication from the kilometer grid of the folded map, the kilometer grid is marked in two mutually perpendicular directions on the front (working) side.

d) Highlighting terrain elements on the map (map marking)

Individual elements of the terrain are highlighted (distinguished) on the map by color tinting, increasing the size of the conventional sign, or underlining for the purpose of obtaining their best perception and readability. Those elements of the terrain are highlighted which determine the structure of the terrain of a given area (commanding heights, main folds in the relief, main rivers, etc.) as well as those local objects and relief forms which, being comparatively small, however, have important significance for the mission being accomplished. Highlighted most often are maps of one color (temporary edition, index map). As a rule, terrain elements which are represented on multicolored maps with bright colors (water, highways, forests, etc.) do not need highlighting.

Highlighting is performed in the following colors:

plantings (forests, gardens, continuous brush, etc.) - by green shading;

narrow strips of forest, plantings near roads - by drawing a thick green line along them;

swamps - by secondary hatchures in a horizontal direction in blue;

rivers and streams - by thickening the lines or coloring them blue;

roads - by thickening the lines of coloring them brown;

populated places - by outlining their outer configuration (sometimes distinguishing the main streets) and crosshatching them in black; the names of the populated places are underlined or printed in larger type;

small local objects (bridges, separate courtyards, etc.) and relief elements (mounds, pits, gullies) by laying out the corresponding conventional sign in a larger size with preservation of the color or circling them in black;

relief - coloring the summits in light brown, thickening some contour lines, and first of all those which show the basic outline of the form of relief (draws, ridges); moreover, thickened contour lines may be shaded (off-shaded) in the direction of descent.

Chapter III

Measurements and Constructions on a Topographic Map

1. Measurement (Determination) of Distances on a Map

a) Measurement of distances with dividers

In measuring straight lines, the points of the dividers are placed on the end points and then, without changing the spread of the dividers, the distance is read from a linear or transverse scale (fig. 28). In the case where the span of the dividers exceeds the length of the linear or transverse scale, some whole number of kilometers is determined from the squares of the kilometer grid and the remainder, in the normal manner from the linear or transverse scale.

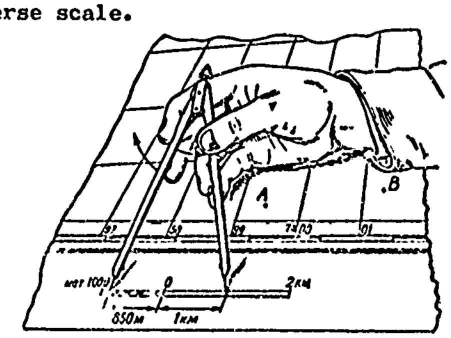


Figure 28. Determining distances from a linear scale using dividers.

It is convenient to measure broken lines by the successive increase in the span of the dividers by straight-line segments as shown in Figure 29. The distance which corresponds to the span of the dividers is determined in the manner presented above.

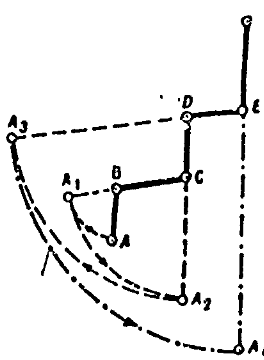


Figure 29. Measuring distances by the method of increasing the span of the dividers.

Measurement of distances along a curve is performed by divider increments (fig. 30). The length of the increment of the dividers depends on the degree o winding of the line but, as a rule, should not exceed one centimeter (for precise measurements). To exclude errors as a result of

the deformation of the paper (map), the increment of the dividers is checked ahead of time along the line of the kilometer grid.

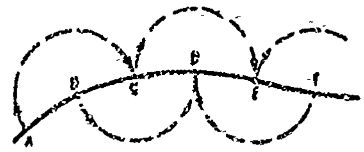


Figure 30. Measuring distances by divider increments.

b) Measuring distances with a curvimeter

When measuring distances on a map with a curvimeter, the arrow should be placed at zero (initial) division ahead of time (by rotating the small wheel) (fig. 31) and then the small wheel is rolled with uniform pressure from the initial to the final point. In this, attention should be paid to seeing that in moving the curvimeter, the readings for the path increase and do not decrease; if this is not the case, the curvimeter should be turned 180°. If the scale of the curvimeter is graduated in kilometers, the distance which is obtained is read directly from the scale. If the divisions of the scale are given in centimeters of the wheel's travel on the map, then the number of divisions which are obtained should be multiplied by the value of a division. To avoid errors, it is recommended that the value of a division be determined by a check measurement along a line of the kilometer grid.

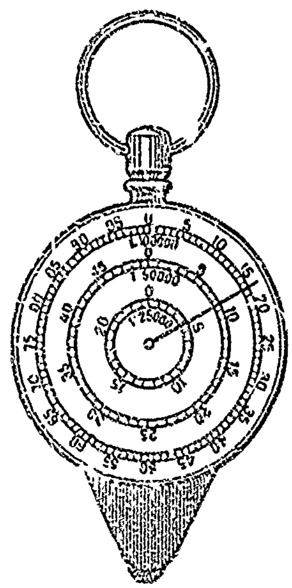


Figure 31. Curvimeter.

c) Augmentation factor for the length of a route measured on a map

In measuring the length of a route along a road on a map, the distance which is obtained is somewhat smaller than the actual distance, since the outline of winding roads on maps is generalized (straightened out) and, moreover, a reduction in the length is caused by the relief and by the fact that the curves on the road are measured along chords. Therefore, it is necessary to apply a special correction to the results of the measurements (Table 19).

Table 19

Correction for increase in length of route measured from a map

Type of terrain	Correction factor with map scale		
	1:200,000	1:100,000	1:50,000
Mountain (sharply broken)	1.25	1.20	1.15
Hilly (average broken)	1.15	1.10	1.05
Flat (slightly broken)	1.05	1.00	1.00

d) Determining distances from rectangular coordinates

The distance, D, along a straight line between points with known rectangular coordinates given in the same system, can be determined most accurately from the formula

$$D = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2},$$

where

x_1, y_1 are the coordinates of the initial point;
x_2, y_2 are the coordinates of the final point.

2. Measurement of Angles on a Map

a) Measuring angles with a protractor (Artillery protractor)

In measuring angles on a map, the center of the protractor is matched with the apex of the angle, and the line of the base of the protractor, with one of the sides of the angle; the reading of the angle (in degrees) is read opposite its second side.

The size of the angle in mils is determined in a similar manner using the artillery protractor.

b) Measuring angles with a chord rule

An arc with a radius equal to the chord of an angle of 1000 mils is described from the apex of the angle being measured (fig. 32). The size of the radius is taken from a chord rule, one point of the dividers is placed at the initial point of the upper horizontal line of the chart, and the

other on a line which is marked with the number 10 (fig. 33). Then we take the size of the chord AB of the angle being measured with the dividers, and we transfer the dividers to the chord rule in such a way that the point of the left leg is on the left (initial) vertical line above the chart and the point of the right leg is on the initial horizontal line. Moving the dividers in such a position from top to bottom (without moving the point of the left leg from the initial vertical line), we go to the intersection of the point of the right leg with one of the sloping vertical lines and take a reading. The number of hundreds and tens of mils is taken from the upper row of numbers of the chart and units of mils - from the left row of numbers at the location of the left leg of the dividers. For example, with a length of chord equal to segment ab (see fig. 33), the size of the angle equals 733 mils.

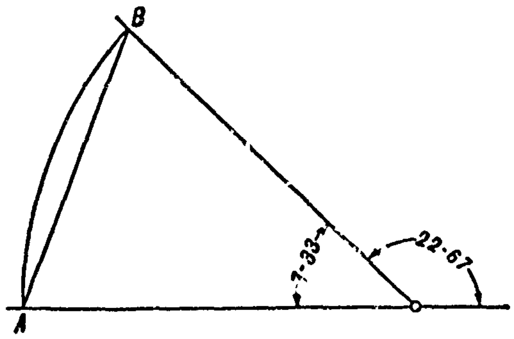


Figure 32. Measuring an angle with a chord rule.

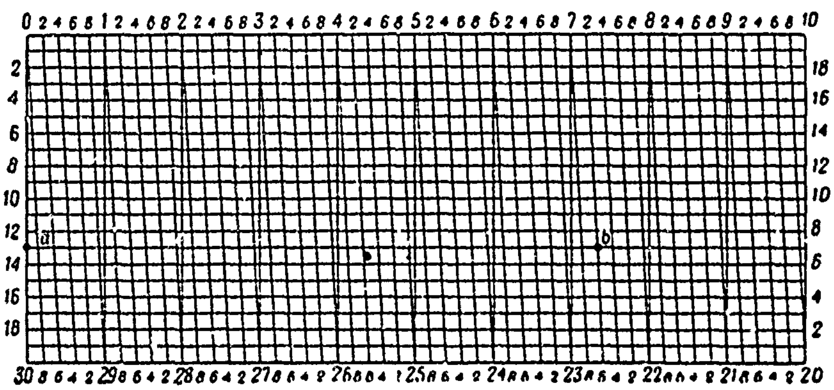


Figure 33. Chord rule.

One of the sides is extended beyond the apex when an obtuse angle is measured. The acute angle, which is obtained (representing the supplement of the obtuse angle up to 3000), is measured by the method described above, but in this, the reading is taken from the lower and right row of numbers of the chord rule, which also determines the size of the obtuse angle. In our example (see fig. 32) the size of the obtuse angle equals 2267.

3. Determining the Altitude of a Point and the Direction and Steepness of Slope from a Map

a) Determining absolute altitudes and relative altitude differences of points

The absolute altitude H of a point on the earth's surface is determined from a map from contour lines and spot readings. If the point is located on a contour line, its altitude equals the reading of the contour line (on fig. 34, H_A = 140 meters). If the point is located between contour lines, its altitude equals the reading of the lower contour line plus the altitude difference of the point above this contour line (determined by interpolation). In Figure 34, H_B = 110 + 5 = 115 meters.

The relative altitude difference of two points equals the difference in the absolute altitudes of these points.

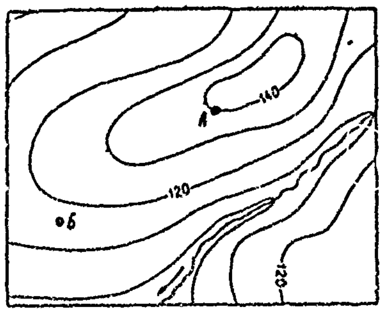


Figure 34. Determining altitudes from a map.

b) Determining the direction of slope

The direction of the drop of slope is determined from the following signs:

from bodies of water (from rivers, lakes), the drop of the slope is in the direction of the body of water;

from indicators of the direction of slope, the hatchure is directed in the direction of the drop;

from the position of the number on the contour line, the numbers are printed primarily in the direction of drop;

from spot readings of points, the drop is in the direction of the smaller spot reading.

c) Determining steepness of slope

The basic formula for the determination of steepness of slope is:

$$\tan \alpha = h/d,$$

where

α is the steepness of slope (determined from the value of the tangent, see Table 51);

h is the height of slope (the relative altitude difference between the upper and lower bends of the slope);

d is the horizontal projection of the slope (distance in a plane between the upper and lower bends of the slope).

The steepness of a slope which does not exceed 20 to 25° may be determined approximately from the formula

$$\alpha^\circ = 60h/d.$$

For rapid (visual) determination of steepness, the interval d between the main contour lines (horizontal projection) is estimated in millimeters and from the formula

$$\alpha^\circ = 12/d(\mathrm{mm})$$

the steepness of the slope is calculated in degrees. This method is applicable only with contour intervals: 1:25,000, five meters; 1:50,000, 10 meters; 1:100,000, 20 meters.

For the determination of the steepness of slope from a scale of horizontal projections (fig. 35), the distance between adjacent primary or thickened contour lines should be taken with a divider or with the use of a strip of paper, apply the dividers to the scale without changing its sp.. and read the number of degrees at the base of the scale.

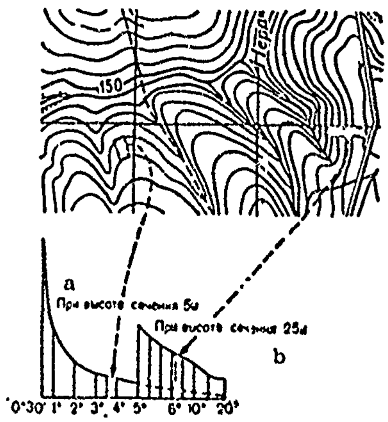


Figure 35. Determination of the steepness of a slope from the scale of horizontal projections (example for a map with a scale of 1:25,000).

a - with a contour interval of 5 meters; b - with a contour interval of 25 meters.

The steepness of slope between adjacent thickened contour lines is determined from a scale corresponding to a fivefold contour interval.

4. Constructing a Profile from a Map

It is most convenient to construct a profile on millimeter paper and, when that is not available, on regular graph paper.

A profile line is drawn on a map, and then the altitudes of the contour lines and points of bend of the slopes are established and written down along the profile line. In this, the markings may be made only at the points of bend and at some contour lines to facilitate determination of altitudes. Having determined the altitude differences, the vertical scale of the profile is selected. The vertical scale is usually taken as 10 times greater than the horizontal scale. A base line is drawn on millimeter paper and, in accordance with the vertical scale which has been adopted, a number of parallel horizontal lines are drawn above it, which correspond to the altitude of the contour lines (every one, every two). Subsequently, placing the paper against the profile line AB on the map, as shown in Figure 36, the initial and final points as well as all contour lines and points of bend of slopes are projected (transferred along the perpendiculars) to it in accordance with the value of their altitudes. The points which have been obtained are connected by a smooth curve.

For the solution of problems for the determination of visibility, a so-called reduced profile is constructed. In this case, only the points of the bend of slopes are strictly transferred to the profile. To determine visibility, all local objects are transferred to the profile (with consideration of their altitudes), which restrict visibility (forests, buildings, etc.).

Figure 36. Constructing a profile from a map.

5. Determining the R[illegible]ngular Coordinates of a Point from a Map

a) Determining rectangular coordinates using dividers (ruler)

For determining coordinates along the X-axis (abscissa) by means of dividers or a ruler a segment is measured along the perpendicular from the given point (target) to the kilometer line which lays below. The numbering of the kilometer line is added on the left to the value which has been obtained and expressed in meters.

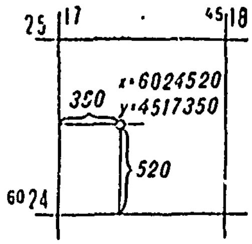


Figure 37. Determining rectangular coordinates from a map.

A similar procedure is also used to determine the coordinates along the Y-axis (ordinate), i.e., a segment is measured along the perpendicular from the target to the kilometer line, which passes to the left and the number of the given kilometer line is added on the left to the value obtained (in meters) (fig. 37).

b) Determining rectangular coordinates using a coordinate square

The coordinate square is applied to the square in which the target is located in such a way that one of its scales coincides with the lower side of the square (fig. 38) and the coordinate square is moved along this line until the second scale coincides with the target. The reading is taken with the coordinate square in this position. The reading along the vertical scale corresponds to the segment along the X-axis and the reading along the horizontal scale to the segment along the Y-axis.

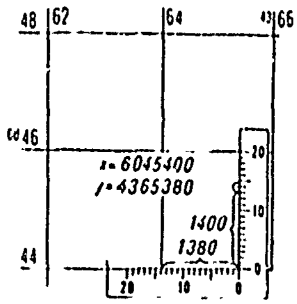


Figure 38. Determining rectangular coordinates with the use of a coordinate square.

6. Plotting a Target on a Map from Rectangular Coordinates

In plotting a target on a map, the square in which the target is located is first found. Then, from the lower left corner of the square, using dividers or a ruler, the segment is laid off at the scale of the map which corresponds to the difference in the abscissas of the target and the lower side of the square. From the point which has been obtained, from the perpendicular to the right, a segment is laid off which corresponds to the

difference between the ordinates of the target and the left side of the square. The point which is obtained provides the position of the target on the map.

Example. Target, x = 5,876, 6000; y = 3, 331, 3000; the target is located in square 7631, the segment along the X-axis equals 600 meters (76,600 -76,000); the segment along the Y-axis equals 300 meters (31,300-31,000). The construction of the segments is shown in Figure 39.

A target is plotted on a map with a coordinate square in the following manner. The coordinate square is placed on the square in which the target is located in such a way that one of its scales coincides with the lower side of the square and the reading along it at the intersection with the vertical line of the square corresponds to the segment along the Y-axis. Then, without changing the position of the coordinate square, we find the reading on the vertical scale which corresponds to the segment along the X-axis.

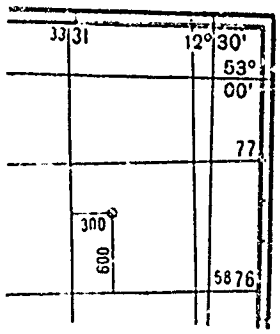


Figure 39. Plotting a target on a map using rectangular coordinates.

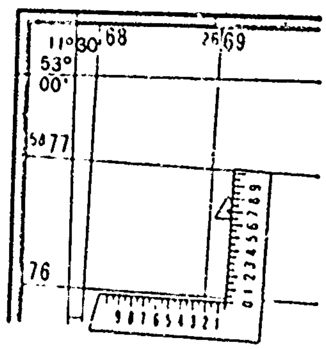


Figure 40. Plotting a target on a map using a coordinate square.

Example. Observation post: x = 5, 876, 700; y = 2, 669, 200. The observation post is located in square 7669, the segment along the Y-axis equals 200 meters and the segment along the X-axis equals 700 meters (fig. 40).

7. Operations with Rectangular Coordinates at a Junction of Zones

The emergences of the kilometer lines of the coordinate system of the adjacent zone, the so-called supplementary grid, are shown and numbered (fig. 41) on maps which are disposed within limits of 2° to the east and west of the boundaries of the meridians of the zone. For calculations and target indication within a common coordinate system from emergences (auxiliary readings on the outer margin) an additional grid is constructed. It is used in the normal manner. The newly constructed grid is an extension of the kilometer grid of the adjacent sheet and should coincide (interface) with it when being glued together.

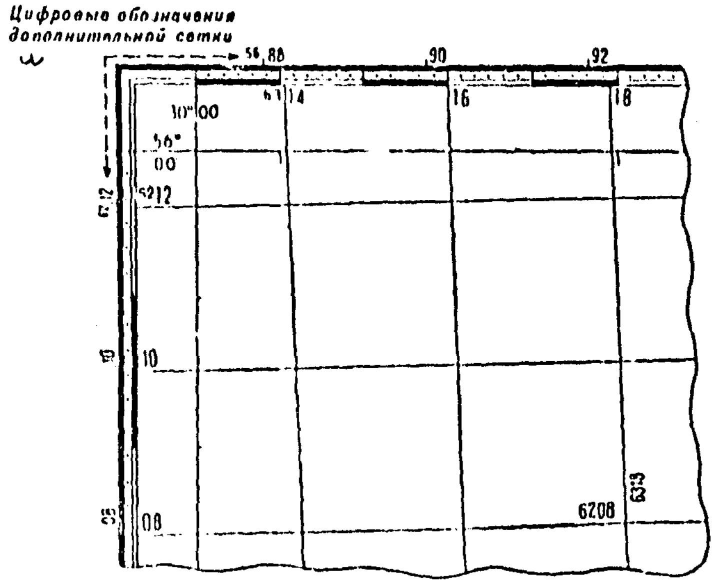


Figure 41. Supplementary grid at the junction of zones.
a - numerical markings of supplementary grid.

8. Determining Geographic Coordinates of Points from a Map and Plotting Points in Accordance with Given Coordinates

For the determination of geographic coordinates of points in an area of interest on the map, meridians and parallels are drawn. This is done by connecting the corresponding minute divisions of the inner margin as shown in Figure 42. The reading of latitude and longitude is done from the grid from the corners of the sheet with the addition to them of the minutes and tens of seconds (minute intervals are divided by points into tens of seconds) and units of seconds are obtained by interpolation. In our example, the coordinates of point A equal 54°58'36" north laitutde, and 37°31'0" east longitude.

To plot a point on a map from given coordinates, the latitude of the point is laid off on the western and eastern margins, and the longitude on the northern and southern margins; the intersection of the straight lines which connect the opposite (obtained) points determines the location of the points desired.

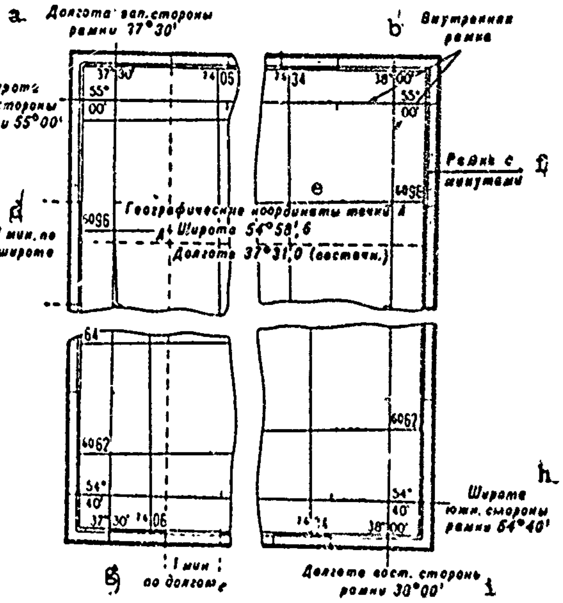


Figure 42. Determining geographic coordinates from a map.

a - longitude of the western side of the margin 37°30'; b - interior margin; c - latitude of northern side of margin 55°00'; d - one minute in latitude; e - geographic coordinates of point A - latitude 54°58'.6; longitude 37°31'.0 (east); f - margin with minutes; g - one minute in longitude; h - latitude of southern side of margin 54°40'; i - longitude of eastern side of margin 38°00'.

9. Measuring (Determining) the Grid Azimuths of Lines of Direction from a Map

a) Measuring the grid azimuth on a map using the protractor

To measure the grid azimuth of a line of direction, the center of the protractor is matched with the point of intersection of the line (or its extension) with one of the lines of the coordinate grid. There may be four positions of the straight edge of the protractor relative to the lines of direction of the grid in measurement, in accordance with which the procedure for reading the angle also changes (fig. 43).

1. The line of direction is approximately within limits of grid azimuth 30°-150°, the position of the protractor as shown in Figure 43a. The grid azimuth is read directly from the protractor.

2. The line of direction is within limits of grid azimuth 210°-330°, position of the protractor as shown in Figure 43b. The grid azimuth equals 180° plus the reading from the protractor.

3. The line of direction is north (or almost north), the position of the protractor as shown in Figure 43c. The grid azimuth equals the reading minus 90° (line of direction to the northeast) of 270° plus the reading (line of direction to the northwest).

4. The line of direction is south (or almost south), the position of the protractor as shown in Figure 43d. The grid azimuth equals 90° plus the reading on the protractor.

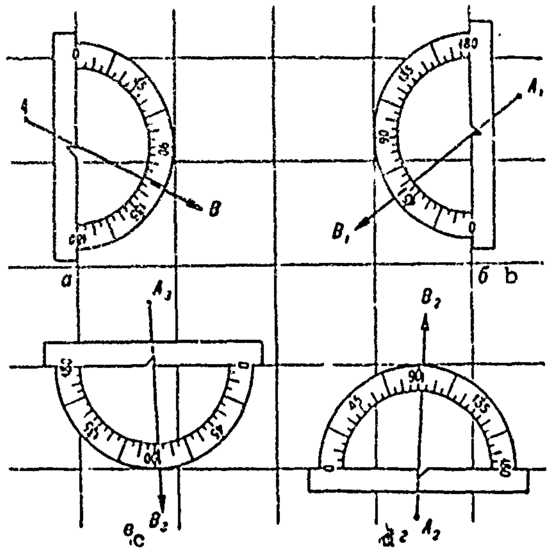


Figure 43. Measuring grid azimuths from a map with a protractor.
a, b - by placing the protractor along a vertical line;
c, d - by placing the protractor along a horizontal line.

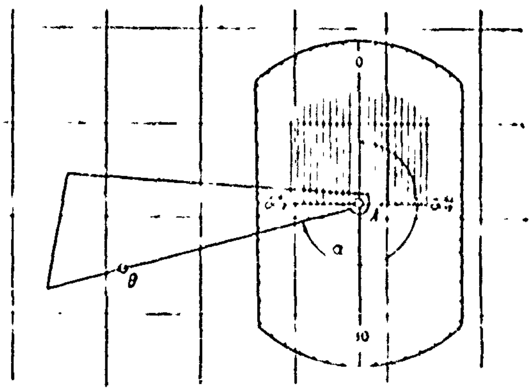


Figure 44. Measuring grid azimuths with an artillery protractor.

b) Measuring grid azimuth with an artillery protractor

A protractor connected to a triangle is placed with its center at the initial point of the line of direction A (fig. 44) with the zero division to the north. Its 30-00 - 0-00 diameter is positioned using the parallel

lines of the protractor and parallel to the vertical lines of the map's coordinate grid. Holding the protractor in the established position, the hypotenuse of the triangle is matched with the terminal point B. Using the red number markings along the edge of the protractor which increase in a clockwise direction, we read the grid angle opposite the edge of the triangle.

Measurement can also be made without the triangle. In this case, the grid azimuty is read opposite a line which has been drawn on the map and which connects the initial and final points.

c) Determining the grid azimuth of a line of direction from the coordinates of points

The grid azimuth is determined most precisely from rectangular coordinates from the formula

$$\tan \alpha_1 = y_2 - y_1 / x_2 - x_1,$$

where

α_1 is the grid azimuth reduced to the first quadrant;

x_1, y_1 are the coordinates of the initial point;

x_2, y_2 are the coordinates of the final point.

The transition from the angle α_1 which has been calculated in the first quadrant to the grid azimuty of angle α for the given line of direction is performed in accordance with formulas which are presented (see Table 52).

10. <u>Changing from Grid Azimuths to Azimuths and Back</u>

The change from grid azimuths to azimuths and back may be performed by formulas for using a graphic sketch. The conversion formulas

$$\alpha = A_M + \Pi;$$
$$\Pi = \delta - \gamma;$$
$$\alpha = A - \gamma;$$
$$A_M = \alpha - \Pi;$$
$$A_M = A - \delta;$$
$$A = \alpha + \gamma;$$
$$A = A_M + \delta.$$

Accepted designations:

α grid azimuth;

A true azimuth;

A_M magnetic azimuth;

δ declination of the magnetic needle (considered with its sign: eastern "+", western "-");

γ meridian convergence (considered with its sign: eastern "+", western "-");

Π correction for direction (considered with its sign).

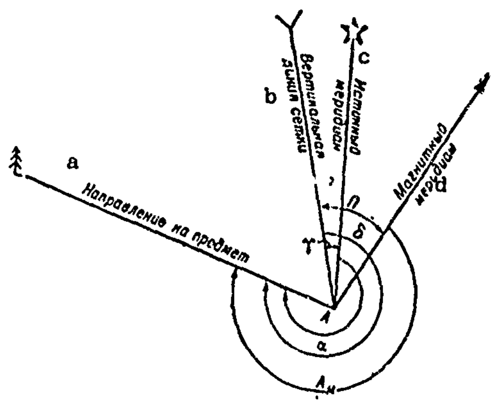


Figure 45. Sketch of the interrelationship of grid azimuths and azimuths.

a - line of direction to object; b - vertical line of grid; c - true meridian; d - magnetic meridian.

Remarks. In the artillery, it is customary to determine the direction correction as a value of the difference in the convergence of the meridians and the declination of the magnetic needle

$$\Pi = \gamma - \delta.$$

In connection with this, the conversion formulas take the following form:

$$A_M = \alpha + \Pi;$$

$$\alpha = A_M - \Pi.$$

From the graphic sketch (fig. 45) the conversion from grid azimuth to azimuth is accomplished in the following manner. On a diagram we show (draw) the given (obtained) line of direction and, conforming to the position of the vertical line of the grid and the line of direction of the magnetic meridian on the diagram, we determine the true azimuth.

11. Plotting Lines of Direction on a Map from Given Azimuths and Grid Azimuths

The plotting of lines of direction on a map, as a rule, is performed using grid azimuths. Therefore, if the line of direction is given in an azimuth, it is necessary to convert it to a grid azimuth ahead of time by one of the methods recommended in Section 10.

The plotting of a line of direction on a map from a grid azimuth which is determined in degrees of measurement is performed using a protractor. A line parallel to the vertical lines of the coordinate grid is drawn through the initial point. The protractor is placed against it by one of the methods shown in Figure 43a and 43b depending on the size of the grid azimuth. A mark (pinhole) is made in the map opposite the corresponding division which is then connected by a straight line to the initial point. This will also be the given line of direction. The plotting of a line of direction on a map from a grid azimuth which is given in mils is performed using the artillery protractor. For this, the center of the protractor is matched with the initial point and oriented with its 0-00 - 30-00 line parallel to the vertical lines of the coordinate grid with the zero division to the north. From the scale with the markings increasing in a clockwise direction, we take the required reading and make a mark on the map through which we also draw the desired straight line from the initial point.

12. Determining Areas from a Map

a) From the squares of the kilometer grid of a map

The area of a sector is determined by calculating whole squares and their fractions, usually estimated by eye. Each square of the kilometer grid on the ground corresponds to: on maps of a scale of 1:25,000 and 1:50,000, one square kilometer, on 1:100,000 maps, four square kilometers, and on 1:200,000 maps, 16 square kilometers.

b) By the geometric method

By means of straight lines, a sector is divided into a system of rectangles, triangles, and trapezoids. Having measured the required values on a map, the area of these figures is determined from the following formulas:

the area of a rectangle P with sides a and b

$$P = ab;$$

the area of a right triangle P with lebs bc

$$P = bc/2;$$

the area of a triangle P with side b and altitude h

$$P = bh/2;$$

the area of a trapezoid with parallel sides a and b, and altitude h

$$P = a + b/2 \cdot h.$$

Chapter IV

Work with Aerial Photos

1. Calculation of the Number of Aerial Photos and the Preparation of a Request for Aerial Photography

a) Calculating the number of aerial photos on a route

Table 20

Number of aerial photos on a route 100 km long

Масштаб (число метров в 1 см) a	Размер аэроснимков, см b		
	18×18	30×30	50×50
30	230	140	85
40	175	105	65
50	140	85	50
60	115	70	42
70	100	60	36
80	90	55	32
90	80	47	28
100	70	42	25
120	60	35	21
140	50	30	18
160	45	26	16
180	40	23	14
200	35	21	13
250	28	17	10
300	23	14	9
400	18	11	7
500	14	9	5

Key: a - scale (number of meters in 1 cm); b - size of aerial photos, cm.

Remarks: 1. In calculating the number of aerial photos on a route longer or shorter than 100 km, the number of aerial photos determined from the table is changed proportionally to the length of the route.

2. In aerial photography with a longitudinal overlap of 60% (used in stereoscopic interpretation) the number of aerial photographs is doubled.

b) Calculation of the number of aerial photos for a region (area)

Table 21

Number of aerial photos for a region with an area of 1,000 square kilometers (longitudinal overlap 20%, transverse overlap 35%)

Масштаб (число метров в 1 см) a	Размер аэроснимков, см b		
	18×18	30×30	50×50
30	9100	2400	860
40	5100	1350	480
50	3300	850	310
60	2300	590	215
70	1650	440	160
80	1300	330	120
90	1000	260	95

Key: a - scale (number of meters in 1 cm); b - size of aerial photos, cm.

(Table 21 cont.)

Масштаб (число метров в 1 см) a	Размер аэроснимков, см b		
	18×18	30×30	50×50
100	820	215	80
120	570	150	55
140	420	110	40
160	320	85	30
180	250	65	25
200	205	55	20
250	130	35	13
300	90	25	9
400	50	15	5
500	33	10	3

Key: a - scale (number of meters in 1 cm); b - size of aerial photos, cm.

Remarks: 1. In calculating the number of aerial photos for a region with a different area, the number of aerial photos indicated in the table is changed proportionally to the size of the area.

2. With aerial photography with a longitudinal overlap of 60% and a side overlap of 35%, the number of aerial photos is doubled.

Example. The area of a region is 3,000 km, the scale of photography is 1:20,000, the size of the aerial photos is 30 x 30 cm, longitudinal overlap is 60%, side overlap is 35%.

The number of aerial photos equals 55 • 3000/1000 • 2 = 330.

c) Request for aerial photography

The request for aerial photography is made on the basis of the missions, the accomplishment of which it should support.

In the request, the following are indicated:

purpose of photography;

area of photography;

required scale of photography (with oblique photography, the scale is indicated along the main horizontal);

types and number of photo documents required;

sequence and times for preparing the documents;

special requirements (overlap, perspective, and others);

time, methods, and place for delivery of photo documents;

times for repeated photography (where necessary).

d) Typical scales for aerial photography

Table 22

Objects and missions of aerial photography	Scale
Terrain	
Detailed study of terrain (routes, water lines, etc.)	1: 8,000 - 1:10,000
Familiarity with general nature of terrain	1:10,000 - 1:40,000
Defense	
Familiarity with general nature of defense	1:12,000 - 1:15,000
Disclosure of type of defensive structures and materiel	1: 4,000 - 1:10,000

2. Preparation of Aerial Photographs for Work

The preparation of aerial photos (mosaics) for work includes familiarity with the aerial photos and tying them to a map; under necessary conditions, the orientation of the aerial photo and the plotting of a coordinate grid on the aerial photo are performed.

In becoming acquainted with an aerial photo, the scale, type, area, and time of aerial photography are clarified. This information is usually found on the moscaic or is reported additionally when sending out the aerial photos. On individual aerial photos, at the moment of photography the following are recorded: number of aerial photo, the size of focal length of the aerial camera in millimeters, the reading of the round level, and time (hours and minutes).

3. Determining the Scale of a Vertical Aerial Photo

a) Determining the scale of an aerial photo from the focal length of the AFA (aerial camera) and the altitude of photography

The scale of an aerial photograph, m_s, is determined from the focal length f and the altitude of photography, H, according to the formula

$$1/m_s = f/H.$$

Example. The focal length is 200 mm, the altitude of photography is 4000 meters:

$$1/m_s = 0.2/4000 = 1/20,000.$$

b) Determination of the scale of an aerial photo from a map

The scale m_s of an aerial photo is determined from a map from the formula

$$1/m_s = l_s/l_k m_k,$$

where

l_s is the length of a line on the photo;

l_k is the length of the line on the map;

m_k is the denominator of the numerical scale of the map.

Where possible, the line from which the scale is determined should lay in the middle portion of the photo and be as long as possible; the terminal points of the line should be sharply expressed on the photo, be shown precisely on the map, and be located at the average altitudes of the given terrain.

For increased accuracy and check, the scale of the photo should be determined at least twice in various lines of direction and the average should be taken as the final result.

Example. The scale of the map is 1:50,000, the length of the first line on the aerial photo is 8.5 cm, on the map 5.2 cm; the length of the second line on the photo is 5.9 cm, on the map 3.6 cm:

$$1/m_s = 8.5/5.2 \cdot 50{,}000 = 1/30{,}588; \qquad (1)$$

$$1/m_s = 5.9/3.6 \cdot 50{,}000 = 1/30{,}500. \qquad (2)$$

The average scale $1/m_s$ equals 1/30,548.

c) Determining the scale of an aerial photo on the ground

The scale of an aerial photo is determined from measurements on the ground or from known dimensions of some object according to the formula

$$1/m_s = l_s/L,$$

where

L is the length of a line which is measured on the ground or the actual size of a known object represented on the photo;

l_s is the length of the line (object) on the photo.

4. Orienting the Aerial Photo

a) Determining the direction of the meridian on an aerial photo using a compass on the ground

The aerial photo is oriented along a line on the ground by procedures which are similar to the orientation of a map, and then a compass is placed on the aerial photograph and the north-south line of direction (magnetic meridian) is drawn along the magnetic needle.

b) Determining the line of direction of the meridian on the aerial photo from a map

Two common points (No. 1 and No. 2, fig. 46) are identified on the aerial photo and on the map and straight lines are drawn through them. The aerial photo is placed on the map in such a way that line of direction No. 1 - No. 2 of the aerial photo coincides with line of direction No. 1 - No. 2 on the map. Then, a line is drawn on the aerial photo which is parallel to one of the side margins of the map. This line will be the direction of the true (geographic) meridian.

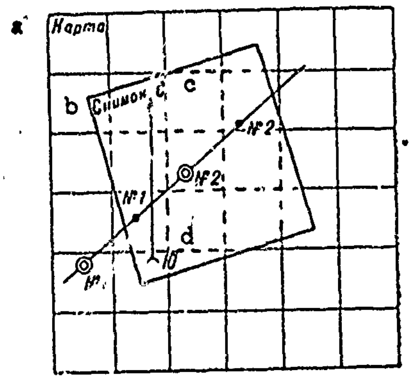


Figure 46. Determining the direction of the meridian on an aerial photo from a map.

a - map; b -photo; c - north; d - south.

c) Determining the direction of the meridian on an aerial photograph from the shadow and time of photography

On an aerial photo, the shadow of some object is identified (tree, tower) and, along the direction of the shadow a line is drawn from which we use a protractor to lay off to the right, if the photo was taken before noon (or to the left if the photo was taken after noon) the angle t which equals a product of 15° (average angle of rotation of the earth around its axis in one hour) times the difference between the statute time of noon (13 hours) and the time of photography. The line of direction which is laid off represents the true meridian.

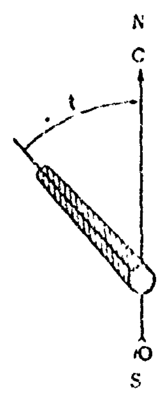


Figure 47. Determining the direction of a meridian from the shadow and time of photography.

Example. Time of photog-aphy is 1000 hours.

$$t = 15° \cdot (13 - 10) = 45°.$$

The calculated angle is laid off to the right of the line of direction of the shadow and the direction to north is obtained (fig. 47).

d) Tying an aerial photo to a map

Tying aerial photos to a map means finding on the map the limits of the sector represented on the aerial photo. For this, one or several of the most prominent terrain objects are identified on the aerial photo (river, lake, railroad, or highway) and they are sought on the map; then, all common terrain features of the aerial photo and the map are identified and from them, the sector represented on the photo is outlined on the map.

To facilitate the tie-in, it is recommended that the scale of the aerial photo be determined ahead of time and that the aerial photo be oriented relative to the directions of the compass. This will permit using procedures recommended for the transfer of an object from an aerial photo to a map for determining the boundaries of the photo on the map (see Section 5, this chapter).

5. The Transfer of Objects from an Aerial Photo to a Map

a) The transfer of objects from a vertical aerial photo to a map from terrain points

Common terrain points are identified on the aerial photo and the map and the required objects are transferred by eye by distances measured from the nearest terrain points. This method is used when great accuracy is not required and the map and the aerial photo have many common terrain points.

b) Transfer of objects from a vertical aerial photo to a map by intersection

Two common points are selected on the map and photo. These points should be selected in such a way that the angle between the lines of direction to the object being transferred is within limits of 30 to 150° and the distances are as short as possible. Segments AC and BC (fig. 48) are measured on the photo and, on the map, arcs are drawn from the corresponding points with radii which equal these segments at map scale; the point of intersection of the arcs will provide the position of the object on the map. To check the intersection, it is performed from a third point.

The conversion of distances of the photo to distances of the map is performed as a rule with the use of a proportional scale which is constructed especially for given aerial photos and maps or with the use of proportional dividers (see Chapter 1).

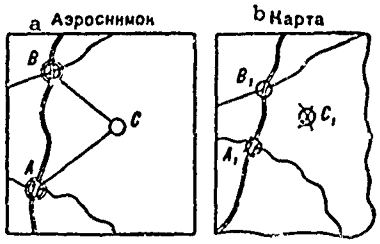


Figure 48. Transfer of objects from an aerial photo to a map by intersection.

a - aerial photo; b - map.

The intersection method is used when the object (targets) must be shown on the map as precisely as possible and there are few common terrain points on the aerial photo and the map.

c) Transfer of objects from a vertical aerial photo to a map from the grid

Three or four common points are selected both on the map and on the photo and they are connected with straight lines. Each side of the similar figure which is obtained is divided into an equal number of parts and the corresponding points are connected by lines. Thus, a grid of desired density will be constructed on the aerial photo and the map from the cells of which the oojects are transferred.

This method is used when it is required to transfer many objects and the aerial photo and map have few common terrain points.

d) Construction of a proportional scale

A proportional scale is used to transfer at map scale segments which are measured on an aerial photo or vice versa. To construct a proportional scale, two common points are selected on both the aerial photo and the map. The selected segment AB is measured on the aerial photo and laid off on a piece of paper (fig. 49). This same segment is measured on the map and laid off from point B in a direction perpendicular to line AB; points A and b are connected by a straight line and lines are drawn parallel to Bb.

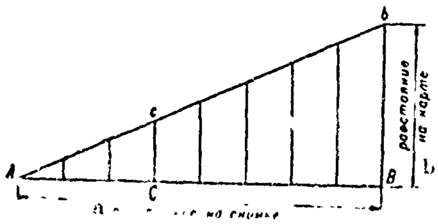


Figure 49. Proportional scale.

a - distance on the photograph; b - distance on the map.

The transfer from the dimensions of the aerial photo to the dimensions on the map is performed in the following manner. The required segment AC is measured on the aerial photograph and is laid off from point A along the line AB. At the point C which is obtained, the measurer is turned parallel to Bb and the span of the divider is reduced until it is tangent to line Ab; segment Cc will correspond to the distance on the map.

e) The transfer of objects from an oblique aerial photo to a map (anharmonic method)

On both the map and the aerial photo, four points are selected which do not lay along the same straight line (fig. 50). On the aerial photo, from one point a, lines of direction are drawn to the three other points b, c, and d, and the object m which is to be transferred to the map; on the map, similar lines of Direction AB, AC, AD are drawn. A strip of paper is placed on the aerial photo in such a way that it intersects all the lines of direction which have been drawn, and the intersection of lines of direction ab, ac, am, and ad with the edge of the paper is marked on it. The strip of paper is placed on the map in such a way that the lines which are drawn on the map from A coincide with the corresponding marks on the strip of paper; after this, the mark of the line of direction to point M is transferred from the paper to the map and line AM is drawn from point A.

The described actions are repeated in order to obtain a second line of direction to point M on the map, but point b is taken as the center of the cluster of rays. The intersection of the two lines of direction at point M will provide the position of the object on a map.

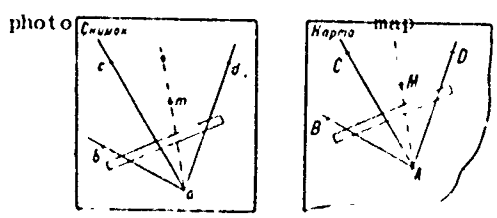


Figure 50. Transfer of a point from the aerial photograph to a map by the anharmonic method.

For a check, all actions are repeated once again, but point c or d is taken as the center of the cluster of rays.

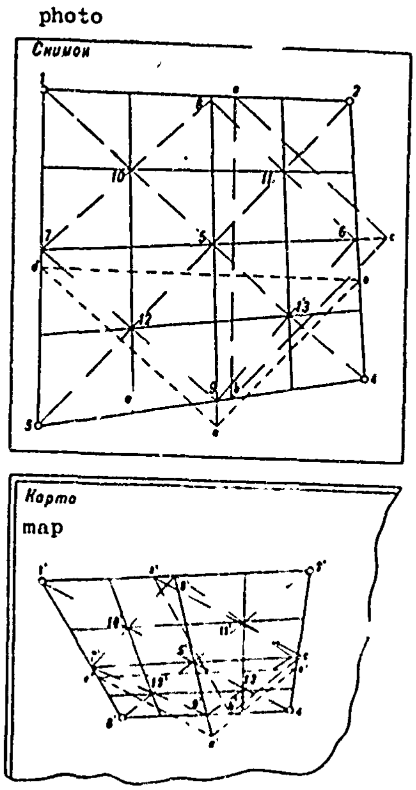


Figure 51. Constructing an oblique grid on an oblique aerial photograph.

f) Constructing a projective grid on an oblique aerial photo for the transfer of objects to a map

Four corresponding points (1, 2, 3, 4) are found on the aerial photo and the map and are connected by straight lines (fig. 51). Diagonals are drawn in the quadrangles which are obtained, and the points of their intersection (5) are found. Straight line ab is drawn at a distance of 2-3 cm to the right of the point (5) parallel to side (1, 3) until its intersection with the sides of the quadrangle. (Similar actions are accomplished on the photo and on the map.) A straight line, ac, is drawn from point a parallel to the diagonal (1, 4), and, from point b, a straight line parallel to diagonals (2, 3). A straight line is drawn through the point of intersection of lines ac and bc and point (5). This line divides the initial quadrangle into two projective figures.

The position of lines (8, 9) is found in the same manner (in fig. 51, the construction is given by a fine dotted line). As a result of the construction of line (8, 9), four projective figures are formed.

Next, the division of the obtained figures into smaller figures is performed in the following manner: diagonals are drawn in the quadrangles which have been obtained and the points of their intersection are connected by straight lines which are extended in both directions.

The projective grids are used when it is necessary to transfer a large number of objects from an oblique aerial photo to a map. The precision of the visual transfer of objects with a size of projective squares of 2 x 2 cm is on the order of ± 2 mm.

6. Plotting a Kilometer Grid on an Aerial Photo and Determining the Coordinates of Points

a) Plotting a kilometer grid on a vertical aerial photo (the quadrangle method)

Four corresponding points are selected both on the aerial photo and on the map. The points should be clearly expressed on the aerial photo, shown precisely on the map, should be disposed at the average altitude of the given terrain, and should form a quadrangle. The selected points are connected by lines and the points of intersection of the sides of the quadrangle are transferred with kilometer lines from the map to the aerial photo. To transfer the points of intersection of the lines (fig. 52), we successively measure on the map segments A-1, A-8, B-2, B-3, C-4, C-5, D/6, and D-7, we transfer them at the scale of the aerial photo, and we lay them off on the aerial photo from the corresponding points in the same direction as on the map. For example, segment A-8, after conversion to the photo scale, is laid off from point a in the direction of d, etc. The transferred points are connected in accordance with the map by pairs: 1-6, 2-5, 3-8, 4-7; these will also be the kilometer lines. They are numbered as is customarily done on maps.

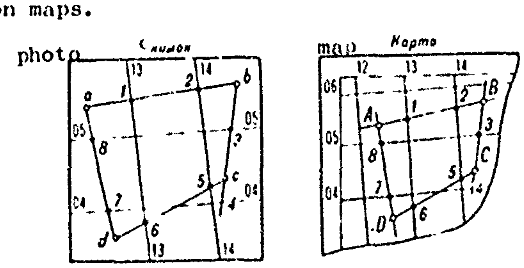


Figure 52. Plotting a kilometer grid on an aerial photo.

b) Determining coordinates of a point from a gridded aerial photo (with a ruler with centimeter divisions)

To determine coordinates of a point, a ruler is placed on an aerial photograph in such a way that its zero line touches the horizontal line of the grid which lies below the point whose coordinates are being

determined and the line which signifies 10 cm touches the adjacent upper line; at the same time, the edge of the ruler should pass through the given point (fig. 53). The reading on the ruler opposite the point, multiplied by ten, will given the size of the segment along the X-axis in meters (fig. 53a).

The segment along the X-axis is determined in a similar manner but the ruler is placed between the vertical lines in such a way that the zero mark is on a vertical line disposed to the left of the point and the line which corresponds to 10 cm touches the vertical line which lays to the right and the edge of the ruler passes through the point the coordinates of which are being read. Figure 53b shows the position of the ruler in reading the y value. Coordinates of point a: x = 18370, y = 04300.

With distances between coordinate lines greater than 10 cm (the scale of the photo is greater than 1:10,000) the coordinates are read with a 20-centimeter ruler as described above; however, the reading which is obtained along the ruler is divided in half in this.

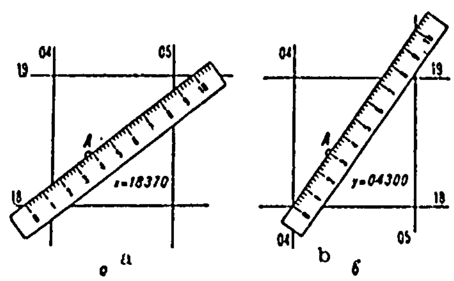


Figure 53. Determining coordinates of a point using a ruler.

c) Determining the coordinates of objects from aerial photos

The coordinates of objects which have been discovered from aerial photos are determined primarily with the use of topographic maps. For this, the objects are transferred from the aerial photo to the map by the methods indicated in Section 5 of this chapter.

With a large number of objects which have been discovered, a kilometer grid is constructed on the aerial photo (see point a of this paragraph) and then the coordinates of the objects are read directly from the aerial photo.

Errors in determining coordinates of objects from aerial photos with the use of a map depend on the nature of the terrain relief, the amount of adeviation of the optical axis of the aerial camera from the vertical, the scale of the map, the error in transferring the object to the map, and the error in reading the coordinates. The total mean error in the determination of rectangular coordinates from vertical aerial photos of flat terrain with the use of simple graphic methods for transferring the position of the objects from the aerial photo to the map is on the order of 2 mm at the scale of the map.

7. Determining the Displacement of Points on an Aerial Photo Due to Terrain Relief

In measurements on aerial photos of mountain terrain, consideration should be given to the displacement of points due to terrain relief. The amount of displacement of points on the aerial photo relative to their true (plane) position as a result of the effect of terrain relief (relief errors) is determined from the formula

$$\Delta r = hr/H$$

where

Δr is the amount of displacement of the point due to relief;

h is the amount that a given point is above the mean altitude of the given terrain;

r is the distance from the principal point to the point whose displacement is being determined;

H is the altitude for photography.

The size of the error Δr for some terrain conditions and given altitudes of photography is given in Table 23.

Table 23

Typical amounts of displacement of points due to relief on a vertical aerial photo

Высота съемки H, м a	Величины смещения точек Δr, мм b							
	равнинная местность, h = 20 м c		холмистая местность, h = 100 м d		горная местность, h = 250 м e		горная местность, h = 500 м f	
	r = 5 см	r = 10 см	r = 5 см	r = 10 см	r = 5 см	r = 10 см	r = 5 см	r = 10 см
2000	0,5	1,0	2,5	5,0	6,2	12,0	12,5	25.0
4000	0,3	0,5	1,2	2,4	3,1	6,2	6,2	12.5
6000	0,2	0,3	0,8	1,6	2,1	4,2	4.2	8.3
8000	0,1	0,2	0,6	1,2	1,6	3,2	3.2	6,3

Key: a - altitude of photography, H, meters; b - amount of displacement of points Δr, mm; c - flat terrain, H = 20 meters; d - hilly terrain, H = 100 meters; e - mountain terrain, H = 250 meters; f - mountain terrain, H = 500 meters.

8. Interpretation of Aerial Photos

a) General procedure for interpretation

The interpretation of aerial photos is preceded by their preparation for work, i.e., clarification (and where necessary - determination) of the scale, type, time, and area of photography, as well as the tying of the aerial photo to a map.

Interpretation is accomplished in a certain sequence. First, the aerial photo is examined without any instruments or with the use of a large magnifying glass with a small magnification (usually 1.5^x to 2^x); in this, the main objects of the terrain (populated places, roads, rivers, etc.) and the most noticeable military objects (firing trenches and communication trenches, artillery firing positions, and so forth) are disclosed. The detailed interpretation is conducted by sections (lines or directions), considering the objects which have been disclosed earlier and their interconnection and with the use of a large-magnification magnifying glass and stereoscope.

The results of the interpretation are recorded with the corresponding conventional symbols directly on the aerial photo (in this, the symbol is placed alongside the photo image of the object) or the objects which have been detected are transferred to a map.

For a more complete and correct disclosure of topographic and tactical objects, it is recommended that the interpretation of even a few separate aerial photos be conducted on the terrain. Aerial photos which have been interpreted in this manner subsequently serve as a key (standard) for the interpretation of other aerial photos of the given area.

b) The most important recognition factors which are used in interpretation

The detection and identification of objects on aerial photos is achieved first of all on the basis of a number of common recognition factors (interpretation factors). The most important of them are: the form of the object's image, the size of the object's image, the tone of the object's image, the shadow from the object, the mutual disposition of objects, traces (signs) of the activity of the object.

Form of the object's image, a direct and permanent recognition factor. It depends on the angle of incline of the optical axis of the aerial camera. In a plane aerial photo, the shape of the object's image is similar to the plane outline of the object on a map, i.e., it corresponds to a view from above.

Size of the object's image, a direct and permanent recognition factor. It depends on the scale of the aerial photo. Actual dimensions of the object are determined from its image on the aerial photo by one of the formulas:

$$L = lm \text{ or } L = L_1 l/l_1,$$

where

m is the denominator of the numerical scale of the aerial photo;

L is the actual dimensions (length and width) of the object;

l is the size of the object's image on the aerial photo;

L_1 and l_1 are the actual dimensions of a known object and the dimensions of its image.

The tone of the object's image, the degree of darkening of the emulsion on the aerial photo. The difference in the tone of the object's image and the surrounding background is a necessary condition for the disclosure of an object. The tone of the object's image depends on:

the general and spectral reflective capability of the object and the conditions of its illumination;

the nature of the object's surface (smooth surfaces turn out lighter than rough surfaces, other things being equal);

the condition of the object's surface (wet surfaces come out darker than dry surfaces);

the conditions for the aerial photography, and the quality of the photographic materials and their processing.

The shadow from the object, the outline and size of the shadow depends on the altitude of the sun (there is no shadow on cloudy days), the relief of the terrain (on which the shadow falls), and the direction of illumination. The shadow supplements the representation of the object's form and permits defining in detail the actual purpose of the object and determining its height. The height of an object can be determined from the length of the shadow by one of the formulas

$$H_{ob} = h_t m_s \tan \varphi \quad \text{or} \quad H_{ob} = h_t H_1/h_1$$

where

H_{ob} is the actual height of the object;

h_t is the length of the object's shadow on the aerial photo;

m_s is the denominator of the numerical scale of the aerial photography;

φ is the angle ofincline of the sun's rays;

H_1 and h_1 are the actual height of a known object and the length of its shadow on the aerial photo.

The mutual position of the objects, an indirect recognition factor of objects which have a certain connection with each other and with the surrounding atmosphere.

Traces (signs) of the object's activity, an indirect recognition factor. Traces of activity of troops and equipment frequently are identified easily on an aerial photo (a network of trails, well-trodden approach routes, traces of tracks, muzzle blast areas at guns which are firing, etc.) and permit establishing the presence and nature of troops and equipment.

Objects are discovered on aerial photos, as a rule, from the aggregate of recognition factors since they are mutually connected and cause each other.

c) Primary recognition factors of terrain objects (fig. 54)

Populated places are easily identified from the characteristic structure of the image (they recall the image of a populated place on a topographic map); in rural populated places, the personal plots are easily visible.

Railroads are easily identified from their straight lines and large radius curves; intersections with vehicular and horse-drawn transport roads are most often at right angles; the tone of the image of railroads is primarily grey (darker than that of highways).

Highways are easily noticeable from the clear outline of the roadbed (in the form of a thin strip of uniform width, primarily of light tone) with straight-line sectors and geometrically correct curves (turns); branches and intersections (at any angle) with other vehicle and horse-drawn transport roads are typical.

Dirt roads are identified from their winding outline of their well-trodden track in the form of lines or narrow strips of non-uniform thickness, primarily of a light grey tone, and with numerous branches and intersections.

Rivers (streams) are identified from the characteristic shape in the form of winding strips of extremely varied width of homogeneous, primarily dark grey tone; bodies of water with dirty, turbid water appear lighter than bodies of water with clean water. Fords are identified from roads which approach the river and shallows which are depicted in a lighter tone than deep sections of the river.

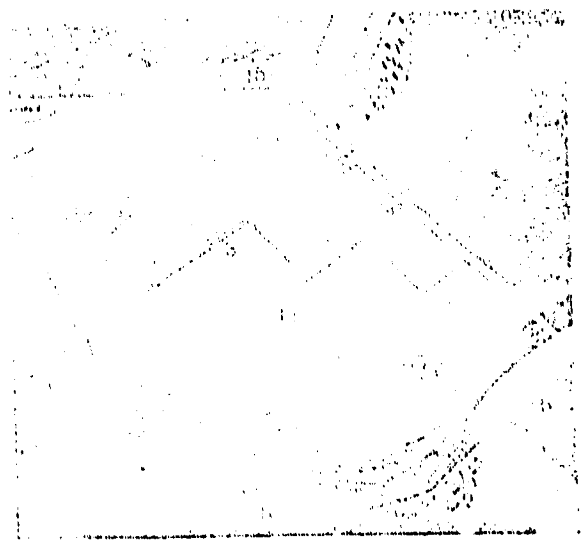


Figure 54. Picture of some terrain elements in a vertical aerial photograph:

1 - city-type populated place; 2 - rural-type populated place; 3 - railroad; 4 - highway; 5 - improved dirt road; 6 - dirt roads; 7 - metal and ferroconcrete bridges; 8 - stone bridges; 9 - bridges for overpass over roads; 10 - coniferous forests; 11 - decidious forests; 12 - brush; 13 - sparse woods; 14 - pasture; 15 - quarries; 16 - swamps; 17 - lakes; 18 - gullies; 19 - peat works.

Forests and brush are obtained in the aerial photo in the form of dark grey sectors with a more or less clearly expressed grainy image.

Relief. Easily noticeable from the configuration of the shadows of gullies, washouts,precipices, and other deep folds of the relief. The form of the relief with gentle slopes on an aerial photo may as a rule be recognized only with the use of a stereoscope.

Soils may be recognized from the tone of the image, but only partially and with a low degree of reliability. Sands are pictured with light, even tone. Rocky soil also provides a light image, with an uneven tone. Clayey, loamy, and sandy loam soils are represented by various tones from grey to dark.

Plowed fields are recognized comparatively easily from the rectilinearity of the outlines of the sectors, and furrows are often visible in the direction in which the soil is worked, the tone of the image of the plowed fields is primarily light. Natural grassy cover (meadow) is represented by an even grey tone.

Swamps are recognized first of all from the tone. The tone of the image of swamps is dark grey, often with fine-grained spots (brush), sometimes with a fibrious structure; a darker tone usually corresponds to the wetter places.

d) Primary recognition factors of some military objects (fig. 55)

Rocket shells have comparatively small dimensions, are easily camouflaged, and therefore their dependable recognition is difficult. Most often, rocket shells are disclosed from indirect factors. The basic ones are: preparation of launch areas and approach routes, the presence of numerous special and transport equipment, elements of positions for all-round ground and air defense, the disposition relative to the front line, and others.

Artillery firing positions are recognized from the images of gun pits (they are disposed approximately in a line), cover for the personnel and transport equipment; approach routes also give away artillery firing positions.

Firing positions for antiaircraft artillery (antiaircraft rockets) are recognized from the presence of pits (in the form of round or rectangular pits) which are disposed in the form of a polygon (more rarely in a line); in the center of the position is the control post, and close to the position are numerous covers for special and transport means.

Mortar firing positions are recognized primarily from the characteristic form of the pits and location. Mortar pits are obtained on aerial photos in the form of a dark small spot with branches to the sides.

Firing trenches and communication trenches are easily identified from the winding zigzag-like or broken outline characteristic of them. The image of the firing trench is composed of the image of a ditch (dark narrow strip), parapet (light strip along the trench), and rifle pits. Communication trenches are distinguished from firing trenches by the rarity of firing pits or by their absence.

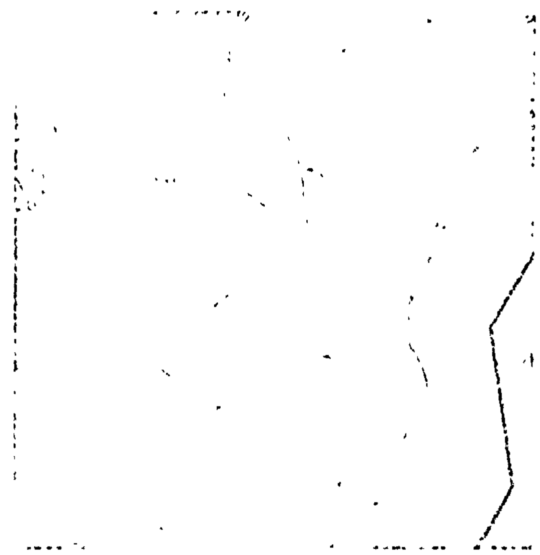


Figure 55. Picture of some tactical objects on an aerial photo:
1 - firing trenches; 2 - communication trenches; 3 - tank pits; 4 - positions for an artillery battery; 5 - positions for an antiaircraft battery; 6 - positions for a mortar battery; 7 - antitank ditches; 8 - cover for wheeled vehicles; 9 - gun pits.

Tanks are identified from the shape of the image (rectangles with a relation of the sides of 2:1) from the uneven tone (the tank turret is of a lighter tone); the trails from the tracks (when moving off roads) are sometimes reflected on the aerial photo in the form of two clear parallel lines.

Vehicles are recognized from their characteristic shape and from shadows. Light vehicles show up in the aerial photo in the form of elongated light spots and the shadow, with illumination from the side, is wedge-like. Open cargo vehicles are pictured on an aerial photo in the form of a rectangle which is darker along the edges; the leading part of the rectangle is narrower (engine part); the shadow from a vehicle is stepped. Covered cargo vehicles are pictured in the form of light rectangles with a darker narrowed front portion.

e) Stereoscopic interpretation

Stereoscopic interpretation is interpretation with the use of a stereoscope (see Chapter I). It permits discovering three-dimensional relief forms in greater detail than with regular interpretation, as well as a number of tactical objects, such as observation posts, radio-technical means, etc.

Stereoscopic interpretation is possible only with the availability of stereopairs, i.e., of two photographs of the same piece of terrain which are obtained from two points of photography. The longitudinal overlap of the aerial photos of 60% provides for stereoscopic examination of any object within the limits of the route which has been photographed.

Setting up a stereoscope of the LZ type (see fig. 17) for the examination of stereopairs is performed in the following manner: the two photos of the stereopair are placed one on top of the other with the overlapping portions, thus matching corresponding objects. The stereopair is then placed beneath the stereoscope and, maintaining the mutual orientation of the photos, they are shifted to the right and to the left by the distance of the corresponding points, on the order of 12 cm. We look in the stereoscope with both eyes simultaneously. First, as a rule, the elements of the right and left photos will be seen separately. As the photos are moved, the corresponding objects will converge and, finally, will merge, thereby transforming from plane to three-dimensional stereoscopic objects. Precise adjustment is usually performed by insignificant movements of only one aerial photo.

A correctly placed stereopair which has been fastened by small weights or tacks permits examining various parts of it later, moving the stereoscope over it (in this, the orientation of the stereoscope relative to the position of the stereopairs should be preserved, otherwise the stereoscopic effect will disappear).

Chapter V

Study of the Terrain in Combined Arms Combat

The study of the terrain consists of clarifying the nature and special features of the relief, protective and camouflage properties of the terrain, road net, natural obstacles, water supply, and other properties of the terrain which affect the operations of troops. Conclusions necessary for the adoption of a decision are drawn on the basis of the terrain study.

Terrain is studied from topographic maps, from military-geographic (topographic) descriptions, by means of reconnaissance, from data from all types of reconnaissance, from aerial photography materials, by interrogating the local population, and from other sources. In studying the terrain, consideration is given to its possible changes in the course of combat operations, as well as the time of year and weather conditions.

Maps of various scales are used to study the terrain. The selection of a map depends on the nature of the mission to be accomplished and the terrain. In studying mountain-forest and forest-swamp terrain, preference should be given to a map with a scale of 1:50,000; in studying average broken terrain, it is expedient to use a map with a scale of 1:100,000; desert and steppe slightly broken terrain can be studied with sufficient thoroughness on a 1:200,000 map. In selecting maps, consideration should be given to their timeliness (reliability); a recent map of a smaller scale which corresponds to the terrain exactly may turn out to be more valuable than a larger scale map which is old.

1. Study of the General Nature of the Terrain

A study of the general nature of the terrain in the area of combat operations is performed by examining a map. In this, the type of relief, basic trafficability conditions, observation conditions, conditions for camouflage, and the protective properties of the terrain are clarified.

The type of relief (flat, hilly, mountain) and its basic properties are established from absolute altitudes, relative altitude differences, and the prevailing steepness of slopes. For this, the location of the main skeletal lines of relief are revealed (rivers, watersheds). The greatest and least altitude readings are placed on the map with notations, and the prevailing steepness of slopes is estimated visually (Table 24).

Table 24

Basic characteristics and tactical properties of relief.

Type of relief	Basic relief characteristics			Basic tactical characteristics
	Absolute height above sea level, meters	Relative altitude difference, meters	Slope steepness, degrees	
Flat	up to 300	up to 25	up to 1	Easily negotiable in any direction; hinders camouflage and protection against weapons of mass destruction.
Hilly	up to 500	25-200	2-3	Negotiable except for individual elements; promotes camouflage somewhat and defense against weapons of mass destruction to some [illegible].
Low mountains	500-1000	200-500	5-10	Hinders massed employment of heavy combat equipment, promotes camouflage and protection against weapons of mass destruction
Average height mountains	1000-2000	500-1000	10-25	Employment of heavy combat equipment possible only on individual directions; relief favors camouflage.
High mountains	above 2000	above 1000	steeper than 25	Employment of heavy combat equipment almost impossible; relief favors camouflage; landslides are possible with the employment of weapons of mass destruction.

The trafficability of an area (strip, direction) apart from relief and soil, is judged by the degree to which the terrain is broken by various obstacles and the degree of development of the road net.

The degree to which the terrain is broken is estimated approximately from the areas occupied by rivers, streams, swamps, ditches, gulleys, steep slopes, forests, and other obstacles which hinder troop operations (Table 25).

Table 25

Basic indicators of terrain trafficability

Variety of terrain	Relief	Area under obstacles	Basic tactical properties
Lightly broken (easily negotiable)	flat, hilly	up to 10%	Massed employment of heavy combat is possible in any direction

(Table 25 cont.)

Variety of terrain	Relief	Area under obstacles	Basic tactical properties
Average broken (negotiable)	hilly, flat	About 20%	Massed employment of heavy combat equipment possible everywhere, hindered somewhat in individual directions
Heavily broken (difficult to negotiate)	mountain, hilly, flat	About 30%	Employment of heavy combat equipment possible only in individual directions

Conditions for camouflage and observation are judged from the nature and volume of individual masks which cover against observation using optical and radio-technical means, and from the relief. The main natural masks are forests, gardens, brush, populated places, various structures, and folds in the relief: gullies, gorges, canyons, etc.

Table 26

Basic characteristics of conditions for camouflage and observation

Variety of terrain	Relief	Area under natural masks	Basic tactical properties
Open	Flat	up to 10%	Camouflage not provided by natural masks; up to 75% of area observed from commanding heights
Semiclosed	Hilly, flat, few mountains	about 20%	Camouflage during disposition at the halt provided completely by natural masks; about 50% observed from commanding heights
Closed	Mountain, hilly, flat	about 30% or more	Camouflage completely provided by natural masks; less than 25% of area observed from commanding heights

In studying the general nature of the terrain, the protective properties of the terrain are clarified primarily from the nature of the dissection of the relief (the deeper and more frequent the folds in the terrain, the less will be the zone of destruction in the general case) and the extent of the forests of the area (in a forest, zones of damage are reduced somewhat). Possible changes in the terrain may be judged from the presence of local objects, particularly those subjected to destruction (populated places, various structures). In this, special attention is paid to objects the destruction of which may hinder considerably the combat operations of the troops (hydraulic engineering structures, water sources in deserts, etc.).

2. Detailed Study of the Terrain

A detailed study of the terrain is usually performed by sectors in accordance with the sequence for the accomplishment of a com' ·' mission, as well as with consideration of possible enemy actions. In this, special attention is paid to those special features of the terrain which, under given conditions, may have the greatest effect on the accomplishment of the assigned combat mission (Table 27).

Table 27

Basic methods for studying elements of terrain

Elements of the terrain and their characteristics	Basic means and methods of study
Basic forms of relief	
Absolute altitude	Map - from altitude readings and contour lines
Relative altitude	Map - from the differences in absolute altitudes of the highest and lowest points
Length (width)	Map - by measurement according to scale
Steepness of slopes	Map - visually, from vertical profile scale or computation (see Section 3, Chapter III)
	Reconnaissance (see Section 4, Chapter IX)
Gullies	
Width	Map - from markings, measurement, or from conventional sign (narrow gullies are depicted by one line on 1:25,000 and 1:50,000 maps with a width of up to 5 m, and on 1:100,000 maps with a width of up to 10 m)
	Aerial photo - by measurement according to scale
Length	Map - by measurement according to scale
	Aerial photo - by measurement according to scale
Depth	Map - from markings or from the difference in readings of the bottom and brow
	Aerial photo - from shadows with corresponding illumination
	Reconnaissance
Soil of bottom	Reconnaissance
	Map - from conventional sign (swampiness)
Precipices	
Depth	Map - from markings or from difference in altitude readings of brow and base
	Aerial photo - from the size of the shadow from the precipice (see p. 125)

(Table 27 cont.)

Length	Map - by measurement according to scale Aerial photo - by measurement according to scale
Hollows and embankments	
Depth (height)	Map - from markings Aerial photo - from shadows with corresponding illumination Reconnaissance
Length	Map - by measurement according to scale Aerial photo - by measurement according to scale
Width	Reconnaissance Aerial photo - by measurement according to scale
Soils	Maps - from the reference materials on 1:200,000 maps, from a conventional symbol (rocky and sandy soils); approximately - from vegetation: pine forests, the soil is primarily sandy and sandy loam; deciduous forests, loamy and sandy loam; meadow vegetation, muddy; steppe vegetation, loamy and sandy loam; swampy, peaty and muddy. From the outline of contour lines: angular - rocky soils, smooth - mellow; presence of gullies - a sign of the predominance of loamy soils. Reconnaissance (see p. 218)
Rivers	
Width	Map - from markings, by measurement according to scale, according to conventional sign: rivers with a width of up to 0.1 mm at map scale are depicted in one line; rivers with a width of up to 0.1-0.6 mm, in two lines without maintenance of scale; wider rivers are represented at scale Aerial photo - by measurement according to scale Reconnaissance
Depth	Reconnaissance Map - from markings, approximately according to the transport rating: depth of navigable rivers is usually more than 2 meters
Speed of current	Map - from markings or approximately from the character of the terrain: in mountains, the current is swift, on hilly terrain, primarily average, on flat terrain, weak. Reconnaissance

(Table 27 cont.)

Soil of bottom	Reconnaissance
	Map - from markings, approximately - from speed of current: up to 0.25 m/sec - mud, 0.25-0.5 m/sec - sand, 0.5-1.0 m/sec - coarse sand, more than 1.0 m/sec - packed clay, pebbles, stone
Bottom relief	Reconnaissance
Banks (steepness, precipices, swampiness)	Map - from conventional signs, contour lines, markings (precipices)
	Aerial photo
	Reconnaissance
Canals (ditches)	
Width	Map - from markings, from conventional signs, by measurement with width of image more than 0.6 mm
	Aerial photo - by measurement according to scale
	Reconnaissance
Depth	Map - according to markings
	Reconnaissance
Soil of bottom	Reconnaissance
Banks	Map
	Aerial photo
	Reconnaissance
Bridges	
Construction material	Map - from conventional sign and markings: D - wooden, M - metal, K - stone, ZhB - ferroconcrete
	Reconnaissance
Length	Map - from markings
	Aerial photo - by measurement
	Reconnaissance
Width	Map - from markings
	Aerial photo - by measurement
	Reconnaissance
Load capacity	Map - from markings
	Reconnaissance
Height	Map - at bridges on navigable rivers, the height of the bottom of the girder above the water level at normal water level is indicated
	Reconnaissance

(Table 27 cont.)

Construction	Reconnaissance
	Map - from conventional sign: double-deck, stone, and ferroconcrete; chain and cable; floating; drawbridges and swing bridges
	Aerial photo - from shadows, particularly with low lateral illumination
Fords	
Depth	Reconnaissance
	Map - from markings
Length	Reconnaissance
	Map - from markings, by measurement according to scale
	Aerial photo - by measurement according to scale
Soil of bottom	Reconnaissance
	Map - from markings: K - rocky, with large rocks; T - hard, even (rocky, pebbly or rubbly); V - viscous (clayey, muddy); P - packed sand
Speed of current	Reconnaissance
	Map - by markings
Dams	
Height (water head)	Map - from markings or from the difference in the water lines
	Reconnaissance
Length	Map - from markings, by measurement according to scale (with length of image more than 1 mm)
	Aerial photo - by measurement according to scale
	Reconnaissance
Width	Map - according to markings
	Reconnaissance
	Aerial photo - by measurement according to scale
Structural material	Map - from markings: K - stone, Bet. - concrete, ZhB - ferroconcrete, D - wooden, Zem. - dirt
	Reconnaissance
Conditions for passage	Map - from conventional sign: passable, impassable
	Reconnaissance

(Table 27 cont.)

Swamps	
Size (area, length, width)	Map - by measurement according to scale
	Reconnaissance
	Aerial photo
Depth	Reconnaissance
	Map - from markings
Vegetation	Map - from conventional signs
	Reconnaissance
	Aerial photo
Trafficability	Reconnaissance
	Map - from conventional sign: impassable (difficult to negotiate), passable by a man in the summertime
Forests	
Size and configuration of area	Map - by measurement according to scale
	Aerial photo - by measurement according to scale
Species of trees	Map - from markings, from conventional signs
	Reconnaissance
	Aerial photo
Height of trees	Map - from markings
	Reconnaissance
	Aerial photo - from shadow of trees
Thickness of trees	Map - from markings
	Reconnaissance
Thickness of forest	Map - from markings
	Reconnaissance
	Aerial photo
Highways	
Class	Map - from conventional signs
	Reconnaissance
Surface material	Map - from markings: A - asphalt and concrete, Ts - cement and concrete, Br - blocks, Kl - clinker, B - cobblestone, G - gravel, K - crushed rock, Shl - cinder, Shch - rubble
	Reconnaissance
Width	Map - from markings
	Reconnaissance
	Aerial photo - by measurement according to scale

(Table 27 cont.)

Steep turns	Maps - from conventional signs (road sectors with radii of turn of less than 25 meters) Aerial photo Reconnaissance
Populated places	
Type	Map - from the image and type of printed name
Number of residents	Map - from markings or the size of the print Reconnaissance
Number of yards	Map - from markings (in rural areas) Reconnaissance
Main thoroughfares	Map - main thoroughfares are shown with a width of 0.6-0.8 mm, the others with a width of 0.3-0.5 mm Reconnaissance Aerial photo

3. Study of Conditions for Observation and Camouflage

a) Study of conditions for observation (camouflage) in a zone

Conditions for observation and camouflage in a zone (on a sector) are evaluated from the degree to which the terrain can be observed from all possible observation points (posts). In this, consideration is given to, first, the employment of all modern means for observation (optical, radar, television, infrared equipment), second, to the change in the position of troops in the course of the battle (arrival at new positions in an attack and maneuver in the defense).

General procedure for study:

to reveal commanding positions, heights, and local objects on which the disposition of observation points (posts) is most expedient;

to determine natural masks (forests, populated places, gardens, brush, folds in the relief) which hinder observation;

to determine the far limit of observation; for this, the greatest heights of the commanding position is compared with the heights of the terrain which lies out in front and the line is determined beyond which the terrain cannot be observed completely or with minor exception from the commanding position, this will also be the far limit of observation;

each possible cover is analyzed in detail, and the selection of observation posts and the limits of sectors which cannot be observed from all observation posts are elaborated in detail.

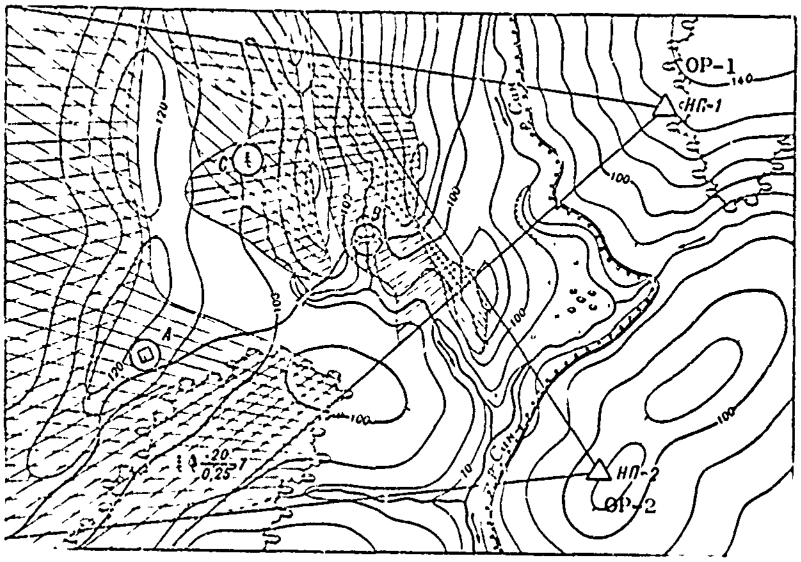


Figure 56. Field of invisibility from two observation posts.

The results of the study of observation are formulated on a map with consideration of each selected observation post by coloring fields of invisibility (red or yellow for friendly troops, blue or purple for enemy troops) or by hatchures. Figure 56 shows an example of a single color formulation of fields of invisibility from two observation posts. The radial direction of the hatchures relative to the observation posts shows that the area of the lone house A is observed from OP-1 and is not observed from OP-2; the area of the bridge B is observed only from OP-2 and the area of the lone tree C is not observed from either observation post.

Conditions for camouflage against observation from enemy ground posts are determined by studying observation conditions "as the enemy."

b) Determination of visibility of targets with consideration of the shape of slopes and the height of obstacles

With the disposition of the observation post and target on the same slope and the absence of raised local objects between them, the visibility of the target from the observation post depends completely on the shape of the slope: visibility is present on an even and concave slope but there is no visibility on a convex slope.

The solution of the problem for determining direct visibility between observer and target with their location on different slopes as well as with consideration of obstacles located between them may follow from the following three different conditions (fig. 57).

1. When the absolute altitudes of the observer and the target are lower than the altitude of at least one of the obstacles located between them.

There is no visibility.

2. When the absolute altitude of the observer and the target are greater than the altitude of any of the obstacles located between them.

There is visibility.

3. When the altitude of even one of the obstacles is intermediate between the altitude of the observer and the target.

Visibility depends on the height of the obstacle as well as on the place where it is located relative to the observer and the target and is determined graphically (by the construction of a triangle on a map) or by computation.

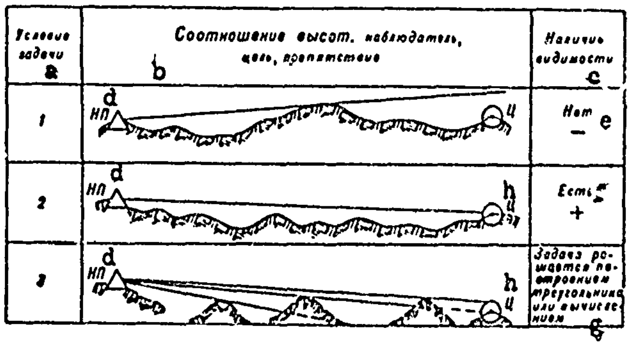


Figure 57. Conditions for direct visibility.

Key: a - conditions of the problem; b - relation between altitudes: observer, target, obstacle; c - presence of visibility; d - OP; e - none; f - present; g - problem is solved by the construction of a triangle or by computation; h - target.

The determination of visibility of a target by the construction of a triangle is accomplished in the following manner. We determine the absolute altitude of the observer, obstacle, target, and their altitude difference above the lowest point (this is always the observation post or the target). The altitude difference which is obtained is laid off in an arbitrary but single scale from the corresponding points along perpendiculars to the observer-target line. A ruler is applied to the points which correspond to the height of the observer's position and the height of the obstacle and a line is drawn (ray of vision). If this straight line passes above the point which corresponds to the position of the target for altitude, the target cannot be seen and if the line passes below, the target can be seen.

Example. From an observation post having an altitude reading of 211 m (fig. 58), target No. 1 (Ts-1) with an altitude reading of 202.9 m cannot be seen since an obstacle is present between them with a reading of approximately 216 meters. Target No. 2 (Ts-2) is visible because the altitude reading of the observation post (211) and the altitude reading of the target

(212) are greater than the altitude reading of any of the obstacles located between them (the greatest reading of the obstacles is approximately 207 m). Visibility from the same observation post to target No. 3 which has an altitude reading of 192 m is determined visually without the required confidence in accuracy. The visibility of a target and, where necessary, the altitude to which the observer should be raised, are determined with complete confidence by the construction of a triangle.

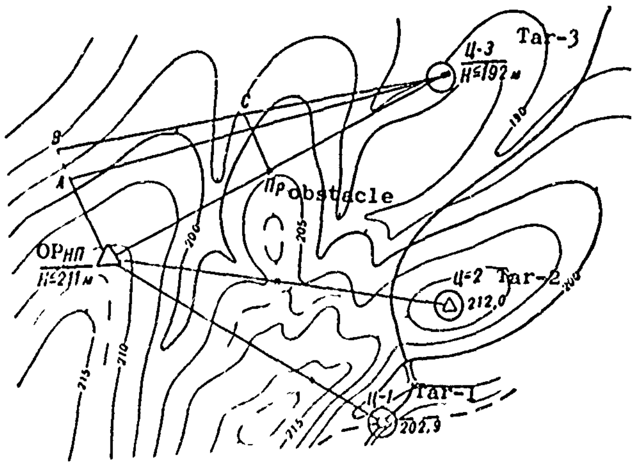


Figure 58. Determination of visibility by constructing a triangle.

We take the altitude of the target's location as zero. An obstacle with a reading of 205 m rises 13 m above the target (205-192) while the observation post rises 19 m above the target (211-192). We lay off the obtained difference at the corresponding points (observation post, obstacle) along perpendiculars to the straight line OP-target. We use a vertical scale for construction as follows: 1 mm on the drawing equals 2 meters on the ground.

A straight line (ray) drawn from the target through the highest point on the obstacle C passes above the point of the position of observation post A. A measurement of segment AB shows that it equals 5 mm; at the scale taken for the construction, this corresponds to 10 m on the terrain. In other words, under given conditions the target is not visible; if, however, the observation post is raised 10 m above the terrain, direct visibility from the observation post to target No. 3 will be assured.

The determination of visibility of a target by computation is performed from the formula

$$t = D/d\ (H_{obst} - H_{tar}) + H_{tar} - H_{op}$$

where

t is the amount by which it is necessary to raise the observer (for open visibility);

D is the distance from the observer to the target;

d is the distance from the obstacle to the target;

H_{op}, H_{obst}, H_{tar} are the absolute altitudes of the locations of the observer, obstacle, and target.

A minus sign for value t will show that it is not necessary to raise the observer since visibility will be preserved even with a drop in the location of the observer by the amount which has been obtained.

c) Determination of target visibility with curvature of the earth and refraction taken into consideration

The task for the determination of visibility of the target and the necessity to lift the observer (radar antenna) which requires consideration only of the curvature of the earth and refraction, arises in a practical manner in organizing observation on flat open terrain or at sea and with a range of observation of 5 km or more. With an insignificant height of target, which can be neglected for practical purposes, the solution of the problem with consideration of curvature of the earth and refraction is accomplished by the formula for the range of the visible horizon or from tables which have been computed by this formula

$$D = 3.83\sqrt{h}$$

where

D is the range to the visible horizon, km;

h is the height to which the observer is raised, meters.

Example 1. The height to which the observer is raised, h, equals 4 meters. Determine the range D of visibility of ground (water surface) targets.

Solution. $D = 3.83\sqrt{4} = 7.66$ km.

Example 2. Range of observation D = 15.5 km. Determine the required height h to which the observer must be raised (m).

Solution. From the formula for the value

$$h = (D/3.83)^2.$$

consequently,

$$h = (15.5/3.83)^2 = 16.4 \text{ meters}$$

Both examples may be solved with the use of tables entitled "Range of direct visibility with different heights to which the observer is raised" (see p. 145) in which the value D is taken directly in the first case and the value h in the second case.

Determination of visibility of the target with consideration of curvature of the earth and refraction, and the height of target is performed from the formula

where

D is the range of visibility, km;

h_1 is the altitude to which the observer is raised, meters;

h_2 is the altitude of the target, meters.

Example 1. The height to which the antenna of a coastal radar (including the height of the shore) is raised above the water, h_1, equals 9 meters. The height of a portion of an enemy ship above the water equals 4 meters. Determine the possible range of detection of the ship by a radar.

Solution. $D = 3.83\ (\sqrt{9} + \sqrt{4}) = 19.2$ km.

Example 2. The range of observation, D, equals 15.5 km. Height of target h_2 equals 4 meters. Determine the necessary height to which the observer must be raised, h_1, to assure visibility of the target.

Solution. From the formula $D = 3.83\ (\sqrt{h_1} + \sqrt{h_2})$ the value

$$h_1 = (D/3.83 - \sqrt{h_2})^2.$$

We substitute the values of the known quantities in the formula

$$h_1 = 15.5/3.83 - \sqrt{4})^2 = 4.2 \text{ meters.}$$

Thus, the height to which it is necessary to raise the observer equals 4.2 meters.

The range of visibility of aerial targets with h_1 equal to zero can be taken directly from Table 29 (see p. 145).

d) Determination of visibility of target with the simultaneous consideration of curvature of the earth, refraction, and obstacles

The problem, the solution of which requires the determination of the visibility of the target with simultaneous consideration of curvature of the earth, refraction, and obstacles arises in the case where observation is organized over a considerable distance (5 km or more) and the direction of observation contains various obstacles in the form of folds in the relief, forests, etc. In this case, the problem is solved by the formula

$$t = H_{obst} - H_{op} + h_1 + (H_{obst} - H_{tar} + h_2)d_1/d_2,$$

where

t is the amount the observer (radar antenna) must be raised to assure visibility;

H_{obst}, H_{tar}, H_{op} are the absolute altitudes of the obstacle, target, and observer's (radar's) position;

d_1 is the distance from the observer to the obstacles;

d_2 is the distance from the target to the obstacles;

h_1, h_2 are corrections for curvature of the earth and refraction, respectively, for distances d_1 and d_2, which are determined by the formula

$$h = (d/3.83)^2.$$

Example. The observer is located at point A (fig. 59), the absolute altitude of which is 220 meters. It is required to determine the presence of direct visibility and in case that visibility is lacking - the necessary amount to raise the observer to assure direct visibility of the exit from a populated place at point B, the absolute altitude of which equals 170 meters.

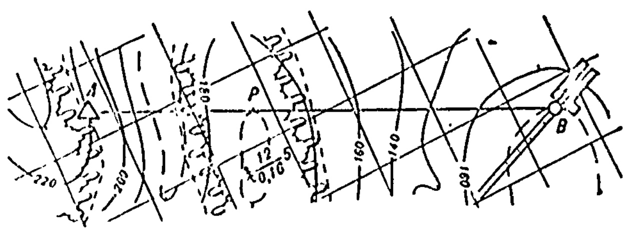


Figure 59. Determination of visibility (example).

Solution. Analysis of altitudes along the direction of observation shows that the largest obstacle (hill with a forest) is located at point P. The absolute altitude of the obstacle equals 202 meters (spot altitude of relief 190 plus 12 meters height of forest). The distance of the obstacle from the observer d_1 = 4.8 km, from the target d_2 - 8.2 km.

First, from the formula we determine the values h_1 and h_2:

h_1 = 1.6 meters; h_2 = 4.6 meters.

Then we place all data in the formula and perform the computation:

$$t = 202 - 220 + 1.6 + \frac{(202 - 170 + 4.6) \cdot 4.8}{8.2} = -16.4 + 21.4 = + 5.$$

Thus, the height to which the observer must be raised at point A in order to assure direct visibility of the exit from the populated place at point B equals 5 meters.

It is expedient to add 1 to 2 meters to the height to which the observer (antenna) must be raised because individual insignificant irregularities in the relief, as well as obstacles in the form of grassy cover, etc., are not reflected on the map and are not considered in the calculation. This should guarantee a more dependable observation of the target area.

e) Range of direct visibility with different height to which the observer is raised.

Table 28

Высота подъема наблюдателя h, м (a)	Дальность прямой видимости D, км (b)	Высота подъема наблюдателя h, м (c)	Дальность прямой видимости D, км (d)
5	9	200	61
10	12	300	66
15	15	400	77
20	17	500	86
30	21	600	94
40	24	700	101
50	27	800	108
75	33	900	115
100	38	1000	120

Key: a - height to which observer is raised, h, meters; b - height of direct visibility D, km; c - height to which observer is raised, h, meters; d - range of direct visibility D, km.

f) Range of open visibility of target with various target heights

Table 29

Высота цели, км (a)	Дальность открытой видимости, км (b)
1	120
2	170
3	210
4	240
5	270
6	300
7	320
8	340
9	360
10	380
15	470
20	540
25	600
30	660
35	720

Key: a - height of target, km; b - range of open visibility, km.

g) Determining the limits of visibility along lines of direction (the "equal segments" method)

The limits of direct visibility from given observation posts within limits which do not require consideration of curvature of the earth and refraction are determined most rapidly using dividers by the "equal segments" method. Its essence consists of the following. Having drawn the given line of direction on a map, we study it carefully and note the points which may represent the start of sectors which cannot be observed: lines of divides or bends of slopes behind which a steeper drop follows, forests, elevated structures, etc. Having determined and marked the altitudes of the

observation post and the obstacles, we begin to disclose the size of the closed sector (or range) for each of the obstacles. For this, with a span of the dividers equal to the distance from the observation post to the first obstacle, we make an increment beyond the obstacle along the direction of observation, having in mind that the ray of vision drops or raises one increment of the dividers for a quantity which equals the difference in altitudes between the observation post and the first obstacle. If, in comparing after the first increment, it turns out that the height of the terrain equals the height of the ray of vision or exceeds it, there is visibility; if it is lower, there is no visibility and it is necessary to make the next increment with the dividers. The comparison between the heights of the ray (with consideration of its subsequent drop or rise) and the terrain is repeated after each subsequent increment right up to open visibility or to the limit of the range of observation.

Having completed the analysis of the first obstacle, in the same manner we analyze the cover beyond the second, third, and subsequent obstacles. The difference in the altitudes of the ray here will be respectively the difference in the altitudes between the observation post and the obstacle — second, third, etc.

In the case where the distance from the observation post to the obstacle is great and does not provide the accuracy for the analysis of visibility within the limits of the dividers increment, the increment of the dividers may be reduced by half, a third, etc.; the difference in the altitudes of the observation post and the obstacle being analyzed is also reduced accordingly.

<u>Example</u>. The altitude reading of an observation post equals 180 (fig. 60). The first obstacle on the line of observation AB which creates a closed sector will be the point in the bend of the relief, a, with an altitude rading of 170, the second the crest of the hill with a reading of 155 at point b, and the third, the crest of a hill with an altitude reading of 180 at point c.

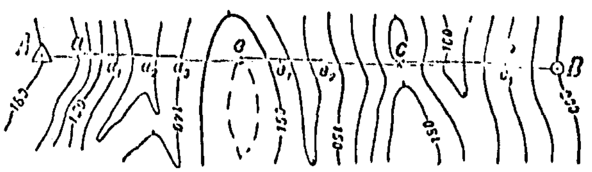


Figure 60. Determining visibility by the "equal segments" method.

We take the segment Aa as the span of the dividers and we make an increment to point a_1. The height of the ray of observation drops on the segment from A to a by 10 meters (180 - 170) and from a to a_1 another 10 meters. Thus, the altitude reading of the ray at a_1 will equal 160 (170-10). But the terrain at that point has an altitude reading on the order of 145. There is no visibility since the ray of vision passes above the terrain by 15 meters (160 - 145).

We take the next increment, to point a_2. The reading of the altitude of the ray here will equal 150 (160-10) and of the terrain, 127. There is no visibility. At point a_3 the altitude reading of the ray equals the altitude reading of the terrain (140). Consequently, visibility is opened and will exist until the terrain rises, in this case to point b. Thus, the first invisible sector will be sector aa_3.

We begin to determine the limit of the closed sector byond obstacle b. The drop of the ray from A to b equals 25 meters (180-155). It does not appear possible to use a dividers increment equal to the entire segment Ab since the visibility within the limits of the increment will remain unclarified. Therefore, we take a dividers span equal to only 1/5 of the segment Ab. For this increment, the drop in the ray should also be reduced five times; it will equal 5 meters (25 : 5). Taking increments with the dividers and comparing the height of the ray and the height of the terrain behind point b, we obtain the following. The height of the ray is 150 meters (155-5) at point b_1, height of the terrain is 143. The height of the ray is 145 meters (150-5) at point b_2, height of the terrain is also 145. Consequently, visibility opened up at point b_2.

The limit of visibility beyond the obstacle c is determined more simply. The height of the observation post and the height of the obstacle are equal (180 meters). Consequently, the ray of vision will pass horizontally and everything that has an altitude reading of less than 180 will be concealed behind the obstacle. Visibility opens up at point c_1.

Depending upon the required accuracy and conditions for work, the solution of the problem by the "equal segments" method may be performed with the use of a ruler, available material, and even by visual estimations instead of by dividers.

h) Determining the visibility of targets and limits of visibility along lines of direction using profiles

Straight lines (rays) are drawn from the point of the observation post through two obstacles for determining the limits of visibility along lines of direction on a profile (fig. 61). (For the construction of a profile from a map, see Section 4, Chapter III). The closed sectors which are obtained in this manner (shaded on the drawing) are transferred (projected) along perpendiculars to the profile line on the map.

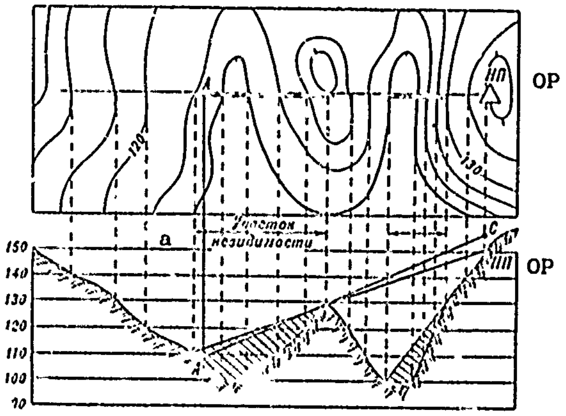


Figure 61. Determining visibility from a profile.
a - sector of invisibility.

The visibility of a target which is disposed on a profile line is determined either directly from the map after the limits of visibility are transferred to it or by means of transfer (projecting) of the target to the profile. In the latter case, in the absence of visibility it becomes possible to determine the amount to which it is necessary to raise the observer to assure visibility. For this, we draw a straight line (ray) from the point of the target's position through the obstacle. The vertical segment between the point of the observation post's position and the line which has been drawn expresses the amount by which the observer must be raised in the vertical scale which has been adopted for this profile. For example, to assure visibility of the target at point A (see fig. 61), it is required to raise the observer by 7 meters (by the amount of the segment (OP-C)).

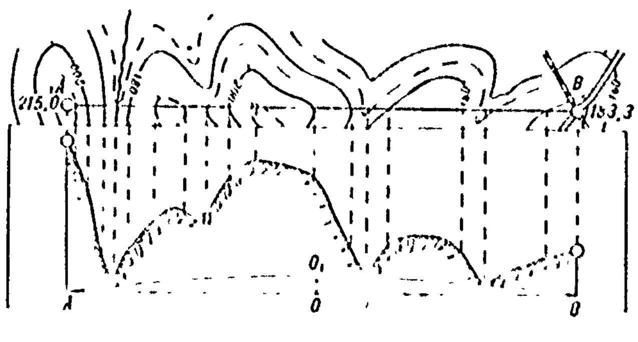


Figure 62. Construction of a profile with consideration of curvature of the earth.

Solution of the problems in this manner but with consideration of the curvature of the earth requires the construction of a special profile. For this, a horizontal straight line (fig. 62) is drawn on a sheet of paper (best if it is millimeter paper) and the segment AB corresponding to the length of the line AB on the map is laid off.

To construct an arc of the arbitrary flat surface of the earth, it is necessary first to determine its downwarping for the given distance. For this, we use the formula

$$h = (D/2 \cdot 3.83)^2,$$

where

h is the height of the arc, meters;

D is the range of observation, km.

The size of the downwarping of the arc, which has been obtained in the vertical scale which has been adopted for the given profile, is laid off on a perpendicular to the horizontal straight line at point O (in the middle of the segment AB). An arc is drawn through point A, B, and O_1 which has been obtained.

Then we give the curve which has been obtained a certain altitude value - the rounded value of the lowest points on the line of direction AB. In our example, the smoothed curve is given the value of 170 meters. Next, placing a sheet of millimeter paper against the line AB on the map, we lay off the altitude position of the most characteristic points of the trace (bends in the relief, forests, etc.) above the curve in the accepted scale. The points which are obtained are connected by a smooth curve.

Subsequent work with the profile is accomplished in the normal method.

i) Determination of fields of invisibility in a sector

To determine fields of invisibility from given observation posts (positions), we first determine the limits of visibility for several of the most characteristic lines of direction in the sector. The number of selected lines of direction depends on the nature of the terrain and range of observation. The more closed the terrain and the greater the range of observation, the more the lines of direction which are planned. On the average, lines of direction are taken every 15 - 20°.

The limits of visibility which are obtained along the lines of direction are connected with each other on the map, conforming to the relief and local objects. The field of invisibility is shaded as shown in Figure 56, or lightly colored.

4. Studying Trafficability Conditions

a) General procedure for studying trafficability conditions

Terrain trafficability is studied with consideration of the mission to be accomplished, the tactical and technical data for the combat and transport equipment, and the weather conditions.

The conditions for the regrouping and maneuver of troops depends primarily on the degree of development and nature of the road net which is studied from topographic and special (road) maps. Cross-country trafficability, which is one of the essential conditions of terrain affecting the conduct of combat operations, depends on the characteristics of the relief, the water net, and the soil-ground and vegetational cover. The special features of the terrain elements which must be considered for the evaluation of their trafficability are determined successively in accordance with the table "Basic methods for studying terrain elements" (see p. 133).

The study of conditions for trafficability is facilitated considerably due to the use of special charts - charts of water lines and charts of trafficability (see pages 30 and 32).

b) Classification of terrain in accordance with trafficability (cross country)

Terrain which is easy to negotiate does not restrict the speed or direction of movement and allows repeated movement over one trail of tracked or wheeled vehicles; it permits the unhampered employment of combat equipment in dispersed formations and movement of columns without reinforcing the ground.

Trafficable terrain hardly limits speed or direction of movements and allows repeated movement of tracked vehicles along one trail, and only individual places must be bypassed or reinforced (passages improved); the movement of wheeled vehicles (with normal trafficability) is somewhat hindered. Trafficable terrain permits almost unhampered employment of combat equipment in dispersed formations and the movement of columns, except for individual directions.

Terrain which is difficult to negotiate permits the movement of tracked vehicles at low speed and limits freedom of maneuver and the movement of many vehicles over one trail; the movement of wheeled vehicles (or regular trafficability) is almost impossible. Terrain which is difficult to negotiate limits the employment of combat equipment in dispersed formations (it cannot be excluded that a portion of the vehicles will not pass under their own power); the movement of columns is possible only over roads and over specially improved routes.

Impassable terrain is inaccessible for cross country movement of tracked and wheeled vehicles.

c) Trafficability of terrain for combat and transport equipment

Trafficability of terrain and speed of movement of combat equipment and transport means are indicated in Tables 30 to 39.

Table 30

Accessibility of slopes (for a rise with hard, dry ground)

Types of equipment and transport means	Steepness of accessible slopes, degrees
Light and cargo vehicles	12-16
Vehicles with increased trafficability	20-30
Pack animals	25
Tractors and prime movers without trailers	30
Tractors and prime movers with trailers	17-25
Tanks	30-35

Remarks. Short rises (5-10 meters) are accessible for tanks with a steepness of up to 40°.

Table 31

Typical speed of cross country movement depending on the steepness of slopes (for a rise in dry weather with normal traction of the running gear with the ground)

Type of vehicles	Speed of movement, km/hr, with steepness of slopes			
	3-6°	6-10°	10-15°	15-20°
Wheeled vehicles	20-15	15-12	12-8	8-5
Tanks	15-12	12-10	10-6	6-4
Prime movers	12-10	10-7	7-5	5-3

Table 32

Accessibility of vertical walls, gullies, escarpments (with dry solid ground at the base)

Types of equipment	Accessible height of wall, m
Tanks	up to 0.85
Tractors and prime movers	up to 0.4-0.6

Table 33

Accessibility of ditches, trenches, wash-outs (with solid ground, walls not caved in)

Types of equipment	Accessible width of ditch, m
Tanks	up to 2.4
Tractors and prime movers without trailers	up to 1.6-2.0
Wheeled vehicles with increased trafficability (three-axle)	up to 0.5-0.8

Table 34

Trafficability of swamps

Type and nature of swamp in warm time of year	Degree of trafficability		
	for tanks	for tractors	for man
Upstream (moss) swamps			
Continuous moss cover, no trees or rarely encountered suppressed pine, many areas of permanently wet land due to outflow of underground water, water stands above the surface or at a level with it (in permanently wet lands)	untrafficable	untrafficable	trafficable with difficulty
Same type of swamp but few permanently wet areas, no water on the surface	trafficable	trafficable	trafficable
Lowland (grassy) swamps			
Continuous grass cover, no trees, willow bushes rarely encountered, water on the surface	untrafficable	untrafficable	trafficable with difficulty
Grassy and mossy cover, willow brush, rarely individual trees, small hillocks, water above the surface or at a level with it	untrafficable	untrafficable	trafficable with difficulty
The same type of swamp, but water below surface	trafficable with difficulty	trafficable	freely trafficable
Continuous can thickets, surface viscously peaty or muddy, water on the surface of the soil or a little below it	untrafficable	untrafficable	trafficable with difficulty
Forest swamps			
Forest of birch or pine, thick grassy cover, hillocks at the trunks of the trees, water on the surface or flush with it	untrafficable	untrafficable	trafficable

(Table 34 cont.)

Sparse forest or of average density of pine, 10-12 m high, peat cover, large hillocks, surface dry	trafficable with difficulty	trafficable with difficulty	freely trafficable
Forest of average density of birsh or spruce, alder bushes, thick, grassy cover, hillocks around trees, many wind-fallen trees, water on the surface or a little below it	untrafficable	untrafficable	trafficable

Remarks. Frozen swamps are accessible for tanks with a depth of freezing of more than 20-40 cm, for tractors 15-25 cm, wheeled vehicles 20-30 cm.

Table 35

Trafficability of continuous peat swamps

Nature of swamp	Allowable pressure kg/cm^2	Trafficability
Peat very compact, dried and slightly moist	1.0	Tanks
Peat compact, average wetness	0.75	Tanks
Peat loose, wet	0.50	Tracked vehicles
Peat very loose, very wet	0.25	Passable on foot, with difficulty
Peat, fluid	0.12-0.14	Unpassable

Table 36

Trafficability for fording rivers

Combat arms and equipment	Allowable fording depth, meters, with speed of current		
	up to 1 m/sec	up to 2 m/sec	more than 2 m/sec
Infantry in dismounted formation	1.0	0.8	0.6
Vehicles			
light	0.6	0.5	0.4
cargo, 3-3.5 tons	0.8	0.7	0.6
cargo, 5 tons	0.9	0.8	0.7
Artillery with tracked prime movers	1.0	0.9	0.8
Tractors	0.8	0.7	0.6
Medium tanks	1.2	1.1	1.0
Heavy tanks	1.5	1.4	1.3

Remarks. 1. Steepness of exits from the water should not exceed 4-6° for wheeled vehicles or 10-15° for prime movers, tractors, and tanks.

2. The depth of the ford includes the layer of water and the layer of mud to solid ground.

3. With hermetization of the engine, the allowable fording depth for wheeled vehicles may be increased by 40-60%.

Table 37

Trafficability of water obstacles over ice (with temperature below -5°C)

Type of load being crossed over ice	Complete weight of load, tons	Necessary thickness of ice, cm
Tracked loads (tanks, armored personnel carriers)	6	22
	10	28
	16	36
	20	40
	30	49
	40	57
	50	64
	60	70
Wheeled loads (wheeled vehicles, wheeled armored personnel carriers)	2	16
	4	22
	6	27
	8	31
	10	35
Guns with prime movers	6	20
	8	23
	10	25
	20	36
	30	44
	40	51
Troops in dismounted formation		
in column in single file	-	4
in column in pairs	-	6
in any formation	-	15

Remarks. 1. With a temperature above -5°C, the strength of the ice is reduced, and particularly so with temperatures above zero.

2. The date which are presented pertain to fresh-water ice.

Table 38

Trafficability of snow cover

Type of equipment	Steepness of slope, degrees	Allowable thickness of snow cover, cm
Tanks	to 5	to 60-75
	5-10	to 40-55
	10-15	to 30-45
	15-20	to 25
Tractors and prime movers	to 5	to 50-60
Wheeled vehicles	to 5	to 25-30

Table 39

Approximate average allowable speed of movement in columns over roads with various surfaces

Type of road surface (type of road)	Allowable average speed of movement on roads, km/hr			
	With new surface	With repaired surface	With area of unrepaired surface comprising	
			up to 10% of entire area	more than 10% of entire area
Cement-concrete	50	-	-	-
Asphalt	50	40-50	20-35	10-20
Crushed stone and gravel processed with binding materials	50	40-45	20-30	10-20
Crushed stone and gravel	40	30-40	20-30	10-20
Roads paved with cobblestones or crushed rock	35	25-35	15-25	10-20
Improved dirt roads	30	20-30	12-20	5-12
Natural dirt roads	25	15-25	8-15	5-10

5. Study of the Protective Properties of Terrain

Terrain, and particularly relief and forests, have a certain influence on the destructive effect of nuclear weapons.

On open flat terrain, a gradual drop in the pressure in the shock wave is observed with an increase in the distance from ground zero. On broken terrain the pressure drops less uniformly with an increase in distance; in some places the pressure drops and in other places it increases somewhat. The pressure in the shock wave is reduced on reverse slopes with an increase in their steepness; on reverse slopes, the velocity head of the air masses is also reduced. Some reduction in pressure is also observed behind

hills with steep slopes. The pressure is reduced significantly in the shock wave in narrow, deep, and winding depressions, gullies, gorges, hollows, etc., which are disposed perpendicular to the direction of propagation of the shock wave.

The injurious effect of the shock wave increases on forward slopes with a considerable steepness, as well as in gullies, gorges, and canyons which are extended in the direction of propagation of the shock wave.

With a surface burst, the effect of the folds in the terrain on protection against the shock wave is felt at any distance from ground zero and with an air burst, only in a distance zone.

With sufficient height (depth), the folds in the terrain screen out luminous radiation and create zones of complete and partial darkening. The light pulse is attenuated considerably in zones of complete darkening (only reflected rays penetrate beyond the screen); in zones of partial darkening, the light pulse is also reduced somewhat (a portion of the rays of the luminous region, sphere or hemisphere, is screened).

The damaging effect of a nuclear burst is attenuated to some degree in forest terrain, particularly in dense forests. The velocity head is reduced as trees brake the moving air masses and the light radiation is screened significantly by the crowns of the trees, especially those of deciduous species.

Forests promote the camouflage and protection of troops against injury by nuclear weapons but they may hinder the actions of troops with the formation of obstructions and fires as a result of nuclear bursts; the probability of fires is greater in coniferous forests and forests with slashings.

Populated placed and local objects which rise up above the earth's surface may be subjected to considerable destruction over large areas. The obstruction of thoroughfares and fires are possible in populated places.

The effect of the terrain on the action and employment of nuclear weapons is established in the process of studying the terrain and its protective properties, natural cover is revealed, and possible zones of destruction and obstacles, and objects against which nuclear strikes are probable, are disclosed.

Natural covers (caves, underground mines, quarries, gullies, gorges, etc.) are disclosed in the process of the entire study of the terrain.

Possible zones of destruction are judged primarily from the relief and the degree of forestation of the terrain. Obstructions of roads and passages in mountains, inundation and swamping of the terrain with the destruction of the dams of reservoirs and with bursts in river channels are possible.

Probable objectives for nuclear strikes (according to terrain conditions) are terrain objects (areas), with strikes against which not only troops located in the zone of the nuclear strike will be injured, but obstacles which

are difficult to negotiate will also arise, the crossing or bypassing of which will delay the overall advance of the troops. Such objectives may be passes and canyons in mountains, crossings over wide rivers, large railroad centers and centers for automobile main highways, dams of reservoirs with large capacity, various defiles, etc.

6. Study of Route of March

The process for styding a route includes three basic stages:

acquaintance with the overall character of the terrain in the direction of the route;

selection of the route (if it has not been assigned by the higher command), highlighting (marking) on a map and measuring its length with the preparations of corresponding route documents;

detailed study of the route and determination of average speed of movement by sectors.

The route is highlighted on the map by drawing a thick, continuous or broken (segments up to 1 cm) line along the road (trail) which is easily visible against the background of the map. The color which is selected most often to highlight the route is brown (on maps of mountain regions with a large number of brown contour lines, it is expedient to use another color). The highlighting line is drawn alongside the road with the purpose of preserving the latter's conventional sign and must be interrupted on bridges and other objects which have great significance in the accomplishment of the march from the point of view of orientation and trafficability. The length of the route is measured by increments of dividers or a curvimeter (see Section 1, Chapter III) and is marked every 5-10 km in increasing totals, beginning with the initial marking (5, 10, 15, etc.). It is necessary to apply a correction to the length of the route as measured from a map (see Section 1, Chapter III).

The route is studied from a topographic map. With the availability of time and the corresponding materials, special maps (road maps) and aerial photos are used; where possible, moreover, a map reconnaissance is performed.

As a result of the study of the route, the following are determined: nature and condition of the road and road structures (bridges, viaducts, pipes); obstacles and routes to bypass them; the possibility of driving from the road and movement off roads; defiles; conditions for camouflage while in motion and at halts; conditions for orientation; protective properties of the terrain; conditions for water supply; sites convenient for halts; lines of deployment; routes for the movement of security podrazdeleniye; average speed of movement over sectors and some other data in accordance with the special features of the composition of the column, situation, time, and planned route of movement.

7. Special Features in Studying Terrain in Winter

The basic changes in tactical characteristics of the terrain in winter consist of the following: to a greater degree than in summer populated places attract troops with the possibility for concealment and warming.

As a rule, the road net is reduced. Many roads, particularly dirt roads, are covered with snow drifts and become impassable for normal wheeled vehicles. The speed of movement over highways is reduced, particularly during periods of ice and snow drifts.

Rivers, lakes, and swamps may be crossed over the ice. The trafficability of forests is reduced sharply due to the deep snow drifts and stumps, blowdown, etc., hidden under the snow. Camouflage and protective properties of deciduous forests are sharply reduced (combat equipment almost completely gives itself away from the air, either directly or from the vehicle tracks).

Frozen soils hinder engineer improvement of the terrain.

Trafficability of the terrain in winter may change sharply from very good with ground which is frozen through (frozen swamps) and the absence of snow cover to very poor with large snow drifts.

The following is recommended in studying terrain under winter conditions:

aerial photos of a recent (winter) flight should be used;

use should be made of data of descriptions of prevailing winds (for determining the nature of drifts), periods for the fall of precipitation and their amount, temperature fluctuations, and time and depth of freezing of soils, rivers, and swamps;

weather summaries and forecasts should be considered systematically;

terrain reconnaissance should be conducted constantly and purposefully.

Chapter VI

Target Indication

1. Target Indication on the Terrain

a) Target indication from a reference point

Target indication from a reference point is a method for indicating an object (target) on a map and terrain by polar coordinates (see p. 60).

Indicated with this method of target indication (on a map or directly on the ground) is a well-known (easily noticeable) reference point (large populated place, lake, etc.), direction to the object, and the distance from the reference point to the object; for example, "Head of column - 20 km east of Millerovo."

For convenience in target indication on the battlefield, easily noticeable reference points are selected ahead of time and they are given conventional designations or numbers. A commonly accepted procedure for numbering is from right to left and, by lines, away from one's self toward the enemy. The location, type, and name of the reference points should be well known to the one who is indicating the target and the one receiving the target. For this, a sketch of reference points is usually prepared.

In indicating a target, we name the closest reference point, direction to the target in mils (from the observer-reference point line) and the distance in meters.

Example. "Reference point No. 5, left 40, add 200, observer in bushes."

If the one indicating the target and the one receiving the target are located at the same observation post, then instead of the reference point-target distance we sometimes indicate the vertical angle from the reference point to the target in mils.

Example. "Reference point No. 2, right 30, drop 5, machine gun in bushes."

Targets which are not very noticeable are indicated successively, i.e., first we indicate the nearest easily noticeable object and then, from this object the target.

Example. "Reference point No. 4, right 20 - corner of pasture, add 100 - bush, dug-in tank to the left."

b) Target indication with tracer bullets (shells) and signal cartridges (flares)

For indication of targets with tracer bullets (shells) or signal cartridges (flares) we establish ahead of time the reference points, order and length of bursts (color of flares), and to receive the target we designate a special observer with the mission of observing the indicated area and reporting the appearance of the signals. A typical form of the report is: "Reference point No. 5, right 40, drop of tracers at bush."

2. Target Indication from a Map

a) Target indication from the squares of the kilometer grid

In target indication from the squares of a kilometer grid, we indicate the square in which the target is located. We designate the square by the numbering of the kilometer lines which are marked on the map in the following order: first we call the number of the horizontal line on the southern side of the square and then the number of the vertical line on the western side of the square.

Example (fig. 63a). "Ivanovka, square 08, 17." The form for recording is, "Ivanovka (0817)."

With the necessity to indicate the target more precisely, the map square is intentionally divided into four parts and each part is designated by the letters of the Russian alphabet ABVG, or the square is divided into 9 parts and numbered from 1 to 9 in a clockwise direction, beginning from the upper left corner and ending with the square which is located in the center.

Example 1 (fig. 63b). "Lone tree, square 08, 18, A." Form for recording, "Lone tree (0818 - A)."

Example 2 (fig. 63c). "Barn, square 08, 19, 6." Form for recording, "Barn (0819 - 6)."

The method of target indication by squares is used when indicating the location of boundary lines, areas, sectors, lines of direction, routes, reference points, targets, etc.

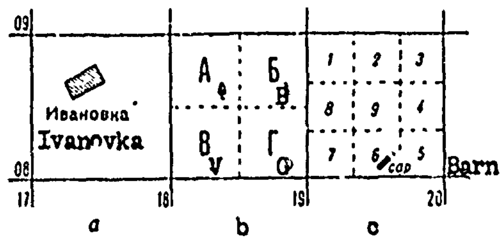


Figure 63. Target indication from squares.

b) Target indication by rectangular coordinates

Target indication by rectangular coordinates is the most precise method for indicating the location of an object (target); it is used to indicate especially important objects (launcher positions, ground zero of nuclear strikes, etc.). The rectangular coordinates of objects are determined (read) primarily from a map or aerial photograph with a coordinate grid and may also be determined from data from the observation of the object by radio-technical, optical, and other means of reconnaissance by solving the direct geodetic problem (see p. 14).

c) Target indication by geodetic (geographic) coordinates

Target indication by geodetic coordinates is the basic method for target indication on a map without kilometer grids; the location of an object is indicated by latitude and longitude. The latitude and longitude of the object are determined from the markings of the parallels and meridians closest to the object with the addition of minutes and seconds which are read with the use of a special chart located on the map (fig. 64; see object M - north latitude 21°40'51", west longitude 80°00'37").

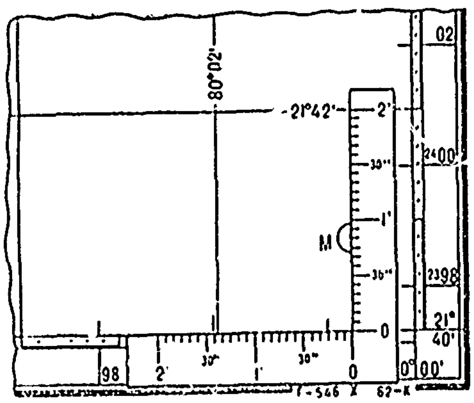


Figure 64. Target indication by geodetic (geographic) coordinates.

d) Target indication from an arbitrary reference point

Target indication from a reference point is used when the area which is embraced by the combat operations is not great (it is sufficient to have three or four reference points) and great accuracy is not required (one can be limited to determining coordinates by eye). In the area of operations one or several reference points are selected, they are given conventional names, and they are written on the map. Then, mutually perpendicular lines (coordinate axes) parallel to the lines of the kilometer grid are drawn through each reference point.

In indicating a target by this method, we first name the nearest reference point and then the coordinates of the target which are determined from the perpendicular lines drawn through the named reference point.

Example (fig. 65). "Sokol, south 200, west 500, antitank gun." In this case, the fork of the field roads is arbitrarily named "Sokol."

3. Target Indication from an Aerial Photo (Aerial Mosaic)

On an aerial photo (mosaic) targets are indicated by the methods which have been adopted for target indication from a map. In target indication by the methods of squares and rectangular coordinates, a coordinate grid is

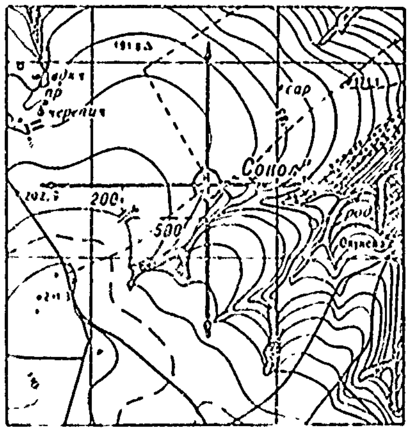


Figure 65. Target indication from an arbitrary reference point.

first placed on the aerial photo (mosaic) and the coordinates are read using a ruler as indicated on page 121.

Chapter VII

Orientation on the Ground

1. Determining the Points of the Compass on the Ground

a) Determining the points of the compass from the sun

The approximate (visual) determination of the points of the compass from the sun is performed on the basis of the fact that in the northern hemisphere the sun is located approximately (statute time, see p. 11):

at 0700 hours - in the east;

at 1300 hours - in the south;

at 1900 hours - in the west;

at 0100 hours - in the north.

The average movement of the sun in one hour equals 15°. The difference in time at the given moment and at 1300 hours (noon) multiplied by 15 will provide the angle at which the sun diverges at a given moment from a direction to the south.

Determination of the compass points from the sun using a watch is accomplished in the following manner. Holding the watch in a horizontal position, we turn it in such a way that the hour hand points its tip in the direction of the sun. A straight line which divides the angle between the hour hand and a line of direction from the center of the watch to the number "1" on the dial indicates the direction to the south (fig. 66).

To increase accuracy in determining the compass points by this method in southern regions, several variations of the method may be used (fig. 67).

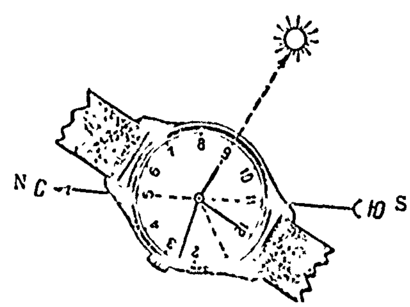


Figure 66. Determining the points of the compass using a watch (first method).

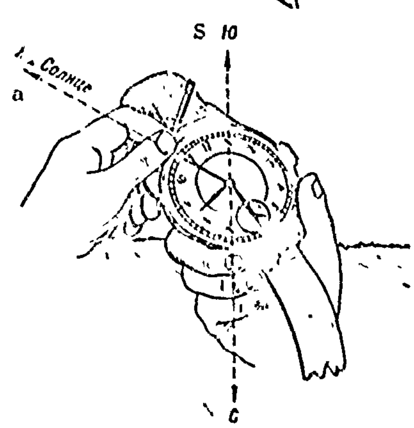


Figure 67. Determining the points of the compass using a watch (second method).

a - to the sun.

We give the watch an inclined position instead of a horizontal position (for latitude of 40-50° - at an angle of 40-50° to the horizontal); in this, we hold the watch with the number "1" away from ourselves;

finding the middle of the arc on the dial between the hour hand and the number "1", we place a match here as shown in the figure, i.e., perpendicular to the dial;

without changing the position of the watch, we turn together with it relative to the sun in such a way that the shadow from the match passes through the center of the dial.

At this moment, the number "1" will be in the direction of south.

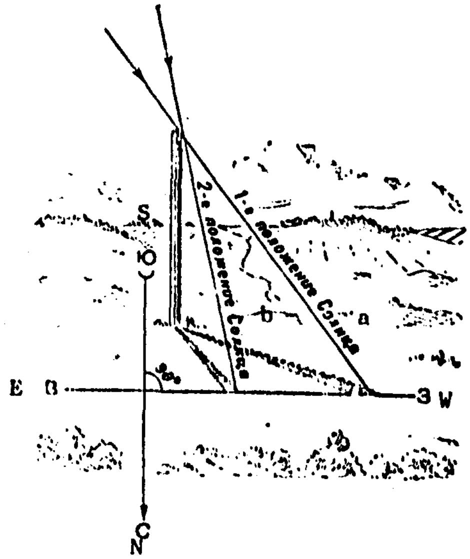


Figure 68. Determining the points of the compass from the movement of the top of a shadow.

a - first position of the sun; b - second position of the sun.

One can determine approximately the direction of the compass points from the movement of the top of a shadow. For this, we place a pole on a flat area and mark the end of its shadow (with a stake, stone). After 10-20 minutes, we mark a second position of the top of the shadow. A direct line from the first mark to the second indicates approximately the west-east line of direction and a perpendicular to it, north-south (fig. 68).

The convenience of this method consists of the fact that it may be used when the time is unknown.

b) Determining the compass points from the North Star

As a practical matter, for simple determinations it is accepted that the North Star is located on a line of direction to the north (deviation - about 1°). The location of the North Star is determined from the Big Dipper constallation: mentally, we extend a straight line which passes through the two extreme stars of the "scoop" (Alpha and Beta) and we lay off on it the distance equal to a fivefold visual distance between these two stars. Here, we find the North Star which is identified by its brightness; it is brighter than all the stars surrounding it, and approximately equal in brightness to the stars of the Little Dipper constellation. In addition, the North Star is the last star in the "handle of the dipper" of the Little Dipper constellation (fig. 69).

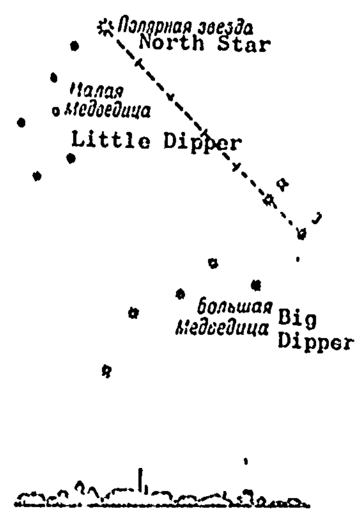


Figure 69. Finding the North Star.

c) Determining the points of the compass from signs of local objects

Signs which are caused by the location of objects with respect to the sun are:

the bark on the majority of trees is rougher on the northern side, and thicker, more elastic (with birches - lighter), on the southern side;

on pines, a secondary (brown, crackling) bark on the northern side rises higher along the trunk;

on the northern side, trees, stones, and wooden, tile, and slate roofs are covered earlier and more abundantly with lichens and fungi;

on coniferous species of trees, the pitch usually accumulates abundantly on the southern side:

anthills are located on the southern side of trees, stumps, and bushes; moreover, the southern slopes of the anthills are gently sloping while the northern slopes are steep;

the spring grass cover is more developed on the northern edges of fields which are warmed by the sun's rays; during the hot period of the summer, the southern edges of fields are darker;

apples and fruits acquire a ripe color (become red, yellow) earlier on the southern side;

the soil near large rocks, structures, trees, and bushes is drier on the southern side in the summer, this can be determined by touch;

snow melts more rapidly on southern slopes; as a result of melting, notches, "spines," are formed on the snow which are directed to the south;

in mountains, oak grows most often on southern slopes.

Other signs:

the altars of orthodox churches, chapels, and Lutheran churches face the east, while the main entrances are located on the west;

the altars of Catholic churches (Polish Roman Catholic churches) face the west;

the raised end of the lower cross beam of churches faces the north;

heathen temples (heathen meeting houses with idols) face their fronts to the south;

openings in large forest tracts, as a rule, are oriented north to south and east to west; the numbering of the squares of forest tracts in the USSR goes from west to east and then to the south.

It is necessary to take several signs rather than just one into consideration in orientation, because influenced by various causes there are actually many deviations from the rules which have been enumerated.

d) Determining the points of the compass using a map

It is necessary to orient a map from terrain lines or reference points for the accomplishment of missions; then we note a reference point along the eastern or western margin of the map in a northern direction. The direction to the reference point will be the direction to the north.

2. Determining Magnetic Azimuths of Lines of Direction on the Ground

a) Determining the azimuth of lines of direction using the Adrianov system compass

Procedure for operations:

stand facing the given direction;

holding the compass in the left hand in a horizontal position in front of one's self and at a height of 10-12 cm below the level of the eye, we free the brake of the magnetic needle with the right hand;

by turning the compass, we bring the zero mark of the graduated circle under the northern end of the magnetic needle;

holding the compass in the oriented direction, by turning the rotating lid we direct the line of sight (the line which passes through the slot and sight) in the given direction with the sight in the direction of the reference point (away from one's self). The matching of the line of sight of the compass with the line of direction to the reference point is achieved by the repeated transfer of the sighting from the line of sight to the reference point and back; it is not recommended that the compass be raised to eye level for this purpose, since in this the orientation of the compass is disrupted and the accuracy in determining azimuth is not increased but, on the contrary, is sharply lowered;

press on the magnetic needle by means of the brake and take the reading of the angle opposite the sharp point of the reading indicator at the sight. This will also be the magnetic line of direction.

b) Determining the azimuth of a line of direction using an AK (artillery compass) system

Operating procedure:

place the mirror lid of the compass at an angle of 45° to the plane of the graduated circle;

face the direction of the given reference point;

take the compass by the fingers of both hands by the housing from below and raise it in front on bent hands to the level of the eye;

direct the compass with the line of sight passing through the center of the compass and the slot in the base of the mirrored lid in the direction of the given reference point;

by turning, match the zero mark on the graduated circle with the northern end of the needle, checking from the reflection in the mirror of the lid;

read the angle on the graduated circle opposite the line of sight at the base of the mirrored lid; this will also be the magnetic azimuth of the line of direction to the given reference point.

3. Finding a Line of Direction on the Ground from a Given Azimuth

The procedure for operating with a compass of the Adrianov system is:

place the reading indicator on the graduated circle at the sight at the given reading for the angle (magnetic azimuth);

releasing the compass needle and roughly bringing the zero reading of the graduated circle beneath its northern end, determine approximately the given line of direction on the ground and turn facing it;

holding the compass in the left hand in front of one's self at a height of 10-12 cm below eye level, orient the compass (bring the zero reading of

the bearing circle precisely under the northern end of the needle);

note on the terrain a distant reference point in the direction of the line of sight of the compass. The line of direction to the reference point will also be the desired line of direction.

The procedure for operating with an AK compass system:

place the mirrored lid of the compass at an angle of 45° to the plane of the graduated circle;

by turning the graduated circle, place the given reading (magnetic azimuth) opposite the object end of the line of sight (the line with the arrow at the slot of the mirrored lid);

holding the compass in the left hand at eye level and looking in the mirror, turn until the northern end of the magnetic needle approaches the zero reading on the graduated circle;

mark a distant reference point in the direction of the line of sight.

The line of direction to the reference point will also be the desired line of direction on the ground.

4. Orienting Maps

a) Orienting maps from the terrain

Orientation of maps from the terrain is possible when the location of the individual is known even approximately and individual reference points are identified. In this case, the map is turned in such a way that the line of direction station - reference point, mentally drawn on the map (or designated on the map by a ruler or pencil) coincides with the corresponding line of direction on the ground.

Orientation of the map from the terrain is used primarily in areas with a sufficient number of reference points and with good visibility conditions, as well as when moving along a road.

b) Orienting a map from a compass

Orienting a map from a compass is used primarily on terrain which has few reference points (in a forest, in desert-steppe areas, etc.) and with poor visibility conditions (at night, in fog, etc.) and is performed in the following manner. On the ground, a line of direction to the north is determined using a compass (or some other method) and then the map is turned so that one of the side margins (the line of direction of the true meridian) is directed towards the north.

The map is oriented more accurately using a compass and the following procedure. A compass with the magnetic needle freed is placed with its center on one of the vertical lines of the map in such a way that the 0° and 180° marks of the graduated circle of the compass (or the straight edge of the AK compass) coincides with this line; then the map is turned until the northern

end of the magnetic needle does not deviate from the zero line by the amount of the direction correction indicated on the map.

5. Determining One's Location on a Map

One's location on a map can be determined by various methods. In selecting the method, consideration is given to the conditions of the situation (including conditions for working with a map and the presence of instruments), the required accuracy, and visibility conditions.

a) Determining one's position on a map from nearest reference points (visually)

The method is employed primarily on regular average broken terrain during daylight with the disposition of one's location on terrain points designated on a map or in the immediate proximity of reference points (local objects or elements of relief).

The operating procedure is as follows:

to orient the map;

to recognize on the map two or three of the closest local objects (or elements of relief);

from the visually determined distance and lines of direction to identified reference points, to mark one's location on the map.

The accuracy in determining one's location on the map by this method depends primarily on the distance to the reference points; the greater these distances, the less dependable is one's location determined. With the location from the reference points at a distance of up to 500 meters, one's location is determined with sufficient accuracy on a 1:100,000 map with an average error on the order of 150 meters.

b) Determining one's location on a map by measuring distances

The method is primarily employed in moving along a road or along a linear terrain point and primarily on closed terrain or under poor conditions of visibility.

The essence of the method: the distance is measured (by speedometer, pacing) from any reference point located at the road or linear terrain point to own location which is being determined; then this distance is laid off on the map along the road (linear terrain point) in the corresponding direction.

The accuracy of determining own location by the given methods depends primarily on the size of the error in measuring the distance on the ground and in laying it off on the map.

c) Determining one's position on a map from distance and direction

This method is employed primarily on open terrain which has few reference points when only one reference point shown on a map is identified. Operating procedure:

measured are the distance (by pacing, chord, binoculars, visually, rangefinder, etc.) from own location to the reference point and the azimuth of the magnetic line of direction from own location to the reference point;

the azimuth is converted to a back azimuth and then to a grid azimuth (see p. 109);

on the map, a line of direction is drawn from the initial reference point by means of a protractor or chord rule along the grid azimuth on which the measured (determined) distance is laid off; the point which is obtained will also be the desired location.

d) Determination of one's location by intersection (from one reference point)

When this method is used, it is possible to determine one's location when located on a road or other linear terrain point and with the visibility of at least one reference point located in such a way that the angle of intersection is at least 20°.

Essence of the method:

the map is oriented and on it a reference point is identified which is visible on the ground from own location;

a compass is used to measure the azimuth of a line of direction from own location to the reference point which is converted to a back azimuth and then to a grid azimuth (the correction is taken from the map);

on the map, the grid azimuth which is obtained is constructed at the reference point (by protractor, chord rule) and the line of direction is drawn in the direction of one's location to the intersection with the linear terrain point; the point of intersection will also be the desired location. The accuracy of the determination of one's location by this method depends primarily on the distance to the reference point (the greater this distance, the greater the error) and the error in measuring the azimuth and constructing the grid azimuth on the map. With a distance to the reference point of about 1 kilometer and the measurement of the azimuth by the AK compass, the average error will be on the order of 100 meters (when working with a 1:100,000 map).

Under these conditions, one's location may be determined graphically:

the map is oriented by compass or terrain lines;

a ruler (better a sight rule) is placed against the reference point on the map and directed by sighting along the ridge to the reference point on the terrain; with the ruler in this position, a straight line is drawn from the reference point towards one's self to the intersection with the linear terrain point. The point of intersection will also be the desired location.

e) Determining one's location by resection

This method is used primarily on open terrain with a small number of reference points but when at least two (better three) reference points can be seen in the distance which are designated on the map and, with observation from own location, are located at an angle within limits of 20-170°.

Own location is determined by resection in the following manner: a compass is used to measure the magnetic azimuths to the reference points and the azimuths are converted to back azimuths and then to grid azimuths (with consideration of the correction shown on the map). Then the corresponding grid azimuths are constructed at the reference points and the lines of direction which are obtained are drawn in the dorection of own location; the point of intersection of these lines of direction will be the desired point. A line of direction from a third reference point serves as a check. When a triangle of error is formed, the location is designated in the center of it.

With distance to the reference points of about 5 km, the error in determining own location may be as high as 600 meters.

The operational procedure using a graphical method is as follows: the map is oriented; having placed the ruler against one of the selected reference points on the map and directed it to the same reference point on the ground, we draw a line of direction toward own position, the same actions are repeated from the second and third reference points. The intersection of the lines will also be the desired point on the map (fig. 70).

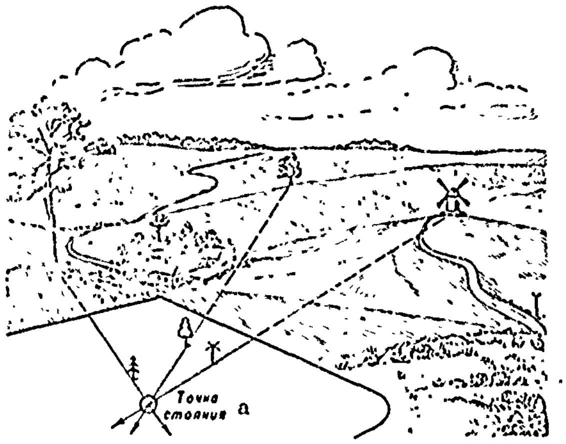


Figure 70. Determining own location by resection.
a - own location.

f) Determining own location on a map using transparent paper (the Bolotov method)

The solution of the problem requires the presence of at least three reference points which are on the map and which can be observed on the ground from own location. Bolotov's method assures the solution of the problem even in the case where preliminary orientation of the map is impossible.

Operating procedure is as follows:

on a sheet of transparent paper which is placed horizontally on a solid base, from one point marked arbitrarily but with consideration of available reference points, by direct sighting (see p. 9), draw lines of direction to

the reference points which have been selected on the ground;

place the transparent paper on the map in such a way that all three drawn lines of direction pass through the corresponding reference points on the map;

transfer (prick) the central and initially marked point onto the map; this will also be the desired position.

6. Movement by Azimuths

a) Preparation of data for movement by azimuths from a map

Movement by azimuths is a method for keeping direction of a path (route) using a compass or directional gyro (see p. 16); it is primarily used with poor visibility (at night, in fog, etc.) and on terrain devoid of reference points (in a forest, in the desert, etc.). With the presence of phenomena of magnetic anomalies, orientation using a magnetic compass is excluded.

Movement by azimuths is accomplished from reference point to reference point. First, prior to the start of movement, the necessary data are prepared - azimuths and distances:

on the map, a route (path of movement) is planned with reference points at the turns;

the grid azimuth and length of each section (leg) of the route are measured on the map;

the grid azimuths are converted into magnetic azimuths with consideration of the corrections indicated on the map;

data for movement are recorded in a table (Table 40) or are recorded directly on the map or a specially prepared diagram (fig. 71).

Table 40

Table of data for movement by azimuths

Number and name of reference point	Grid azimuths, ° degrees	Direction correction, degrees	Magnetic azimuths, degrees	Distances	
				in meters	
1 - lone courtyard	23	+8	15	1557	1038
2 - place where road enters woods	338	+8	330	645	430
3 - intersection of road and clearing	4	+8	356	1020	680
4 - pit at clearing					
5 - forester's house	102	+8	94	705	470

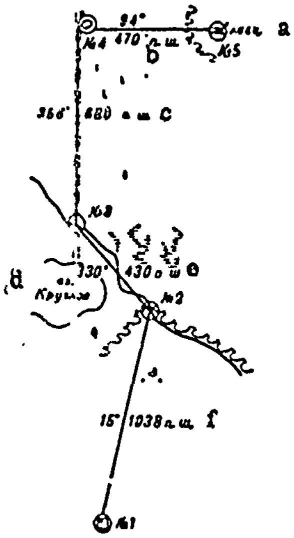


Figure 71. Sketch of route for movement by azimuths.

a - forester's house; b - 470 two paces; 680 two paces; d - Lake Krugloye; e - 430 two paces; f - 1038 two paces.

b) Movement by azimuths

At each turning point, beginning with the initial point, the line of direction of movement on the ground is found from the given azimuth with the use of a compass. It is desirable to select and remember the largest possible number of distant reference points on the line of direction of movement. In movement, a record of distances is maintained (meters, two paces, time).

In the case where no reference point is found on covering the assigned distance, a sign is placed at the point of arrival or a soldier is left and the reference point is looked for, covering the area around the point with a radius of about 0.1 of the path covered from the preceding reference point.

Additional reference points are used to maintain direction in movement: stars, wind direction, the line of direction of a column, and other auxiliary signs.

c) Bypassing obstacles

Obstacles may be bypassed by one of the following methods, depending on conditions. The first method which is used with the availability of visibility across obstacles is:

note a reference point along the direction of movement on the opposite side of the obstacle;

bypass the obstacle and continue movement from the noted reference point; estimate the width of the obstacle by eye, and add it to the distance which has been covered.

The second method which is used in the absence of visibility across an obstacle consists of accomplishing the bypass over straight lines of direction, the azimuth and length of which are strictly recorded for coming

out on the assigned direction. The example of bypassing a mine field with this method is shown in Figure 72.

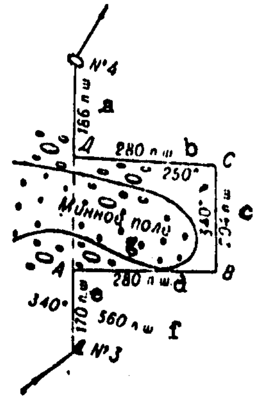


Figure 72. Bypassing an obstacle.

a - 186 two paces; b - 280 two paces; c - 204 two paces; d - 280 two paces; e - 170 two paces; f - 560 two paces; g - mine field.

7. Orientation from a Map (at the Halt)

Orientation by map is the basic method of orientation on unfamiliar terrain. It is accomplished in the following fundamental sequence:

the map is oriented;

reference points are identified (local objects and elements of relief) which are common to the map and the terrain;

own location is determined;

the map is compared with the terrain.

Orientation of the map is performed by compass or by a linear object (road, terrain point, etc.).

The identification of reference points is the most important stage in orientation by map since only by discovering on the map the images of local objects or elements of relief which are observed on the ground is it possible to determine one's location.

In examining the terrain, we first note terrain objects which are the largest and which are best distinguished, as well as those which are encountered comparatively rarely in the given area; in this, attention is paid to their mutual position and the disposition relative to the points of the compass. For example, a lake is located west of own location, a highway passes east of the lake from north to south, etc. Using these signs, we find the noted terrain objects on the map and the correctness of their identification is checked from the surrounding local objects and the relief.

If we have not succeeded in identifying reference points, it is impossible to accomplish orientation from a map at the given place and, if

the situation permits, we should change the location in such a way that visibility of other reference points is opened up, after which we attempt to identify these reference points on the map. With the discovery of the corresponding reference points on the ground and on the map, one's location is determined by one of the methods presented in Section 5 of this chapter.

The concluding stage of orientation is clarifying the surrounding situation; it is performed by the method of the successive comparison (juxtaposition) of the map with the terrain.

In order to find on the map the image of an object which is observed on the ground, then without destroying the orientation of the map one should stand facing the object being determined, place a ruler against own location, and direct it toward the required object; then, examining the map along the edge of the ruler and in conformance with the distance to the object which is estimated by eye, we find the desired conventional sign.

In order to determine on the ground an object which is shown on the map more easily, we place the ruler against the line from one's location to the object and, in the direction of the rule with consideration of the distance, we find the desired object.

8. Orientation from a Map While in Movement on a Vehicle

Orientation while moving on a vehicle which is not equipped with navigational equipment is performed in the following manner.

The route is highlighted ahead of time, before the start of movement, on a 1:100,000 map (1:50,000, 1:200,000). Check reference points are marked (at a distance on the order of 5-10 minutes of movement from each other), the distances to them are determined, and they are marked on the map with increasing totals at the corresponding reference points; on sectors of the route where it is particularly difficult to adhere to the required direction (on moving out of a populated place, in a forest, in a desert, etc.), the azimuths of the direction of movement are determined and written down.

At the start point (and subsequently, at each check reference point) the sector of the route to the first check reference point (and subsequently to the next check reference point) is glanced at quickly on the map; during movement, the map is kept oriented, observed terrain objects are identified on the map, and from them we mentally record our advance along the route.

In doubtful cases (when the map does not completely correspond to the terrain) the location is elaborated (checked) from the distance which has been covered and which is read from the speedometer (for which the initial reading on the speedometer is recorded at the start point).

If doubt has arisen concerning the direction for further movement, it is elaborated (checked) by compass.

On departing from the route and losing orientation (which is possible with careless orientation, as well as with sudden changes in the terrain) it is necessary to note on the map the approximate (probable) location from the distance which has been covered from a reliably identified reference point (it is read from the speedometer) and the direction of movement (it is determined approximately by compsss with consideration in turns of the route). Then, we should attntively study the surrounding local objects (particularly their position with respect to the relief), identify them on the map, and elaborate one's location, after which we plan our emergence on the route.

It is preferable to return along the track of our vehicle to the last well-identified reference point if we did not suceed in restoring orientation, and continue movement along the route from here. In some cases (in an area of many linear reference points and a situation not fraught with danger), movement may be continued in the former direction until emerging at a linear reference point and here we can elaborate our location and then plan to come our on our route of march.

Special features in orienting at night. Orientation at night is usually hindered somewhat because of poor visibility of reference points and the inconvenience of working with a map.

In moving at night, where possible, the route should be planned along roads or along linear reference points which are easily visible at night (along electrical transmission lines, railroads, etc.).

For orientation at night, one should:

select reference points with consideration of their best visibility in the illumination which will be employed on the march or without illumination; large, light paint, projected against the sky or on the surface of the water, falling in a ray of light from a headlight;

select reference points in such a way that the distances between them are shorter than those allowed during the day where possible;

highlight the route on the map with a thick line of a bright color (yellow and orange, poorly visible during artificial illumination, are not used to highlight the route);

memorize the route of movement so firmly as to be able to reproduce it graphically from memory;

where possible, be located in a dark room or in a room illuminated with red light for 30 minutes before the start of a march at night, which provides for the eyes to adapt to darkness;

when using a map en route, to preserve darkness adaptation use a red light (flashlight with a red light filter);

check the correctness of direction of movement more often by compass and stars.

We orient primarily by compass or by using navigational equipment, when moving cross country at night.

9. Special Features of Orientation Under Various Terrain Conditions

a) Special features of orientation in a forest

The basic means for orientation with respect to the points of the compass and maintaining direction of movement in a forest off roads is the compass. Auxiliary methods of orientation may be: orientation from signs of local objects and from stars.

The following are used in a forest as reference points:

clearings, roads, and their intersections (forks);

rivers and streams (the direction of their low, characteristic bends and crossings are considered);

clearly expressed relief forms (precipices, steep slopes, summits, mounds, pits);

forest glades, cuttings, boundaries of sectors of sparse woods, brush, slash fires;

swampy sectors and others.

In moving in a forest by azimuths, it should be considered that a large error in measuring distances is possible. The thicker the forest and the more difficult it is to negotiate (windfall, thick undergrowth, and other obstacles) the greater the error will be. In a forest which is difficult to negotiate, the error may reach a value equal to 50% of the path which has been covered. In this case, it is expedient to determine the distance from time, based on a previously determined average speed of movement.

b) Special features of orientation in desert-steppe terrain

The basic method for adhering to direction when moving off roads is movement by azimuths.

The basic reference points are prominent elevations and rare local objects including canals, wells, and structures connected with religious cults.

The following local signs may be used for adhering to direction:

wind direction;

the direction of grooves in clays and limestone (in the direction of prevailing winds);

the direction of dunes, barkhans, and ripples in the sand (perpendicular to the direction of the winds);

the steepness of the slopes of dunes and barkhans (upwind - up to 15°, downwind - up to 40°);

the accumulation of snow in depressions and behind obstacles from the downwind side;

snow caps on the downwind side of snow banks;

the direction of snow waves and ripples (perpendicular to wind directions). For the purpose of using extremely distant reference points, it is expedient to have a map for a large area.

c) Special features of orientation in large populated places

For orientation, it is necessary to use large-scale maps (1:25,000 or greater), plans and aerial photographs. It should be taken into consideration that on maps of a scale of 1:50,000 or smaller, the blocks are generalized, and only the main streets and thoroughfares are plotted to the extent permitted by the scale.

The following may serve as the main reference points in cities:

main (highway) streets, squares;

prominent industrial enterprises, towers, high buildings;

railroads, rivers, canals, and bridges (viaducts). A traffic control service must be organized for the passage of columns through large cities.

d) Special features of orientation in mountains

Orientation in mountains is most convenient by examining the terrain from commanding heights which assure the best view. The following are most generally used as reference points:

roads, residences, and geodetic and astronomical markers;

rivers, streams, and, in particular, the locations of their confluence;

prominent summits of mountains, bluffs, and cliffs;

canyons, steep slopes (rocky or with talus slopes);

the outlines of forests, meadows, and glaciers. The overall direction of movement is adhered to by compass. In addition to this, the most important sign for orientation is the profile of the route - upgrades, downgrades and their steepness, turns in the road, their position relative to the slopes (for example, a downgrade to the left, an upgrade to the right, and distances between turns).

It is also useful to know the following specific signs:

in many areas, the southern slopes of mountains are more gently sloping and the northern slopes are steeper;

trees of deciduous species (first of all, oak) grow primarily on southern slopes and coniferous trees on northern slopes;

grass cover predominates on southern slopes and woody vegetation on northern slopes;

the zone of snows on northern slopes drops lower than on southern slopes;

vineyards, as a rule, are laid out on southern slopes.

With visual estimation of distances, it should be remembered that because of the great transparency of the air, 'sudden bends, and large forms of relief in mountai s, distances to objects appear considerably smaller than they actually are.

Chapter VIII

The Use of Navigational Equipment in Orientation

1. Orientation Using a Directional Gyro

a) Turning the directional gyro on and off

A directional gyro (fig. 73) installed in ground vehicles permits holding to the required direction for 1.5 hours with an error no greater than 2° (with careful balancing, the instruments can be used continuously for up to 5 hours without reorientation).

The course of the vehicle (direction of movement) is estimated from the mutual position of the scale (the scale is fastened to the axis of the Cardan joint of the gyroscope and is divided into 360° or 6000 mils) and the index which is rigidly connected with the instrument housing; therefore, when the vehicle is turned, the reading on the scale is changed by the angle of turn of the vehicle.

The directional gyro is turned on only in a stationary vehicle in the following sequence:

a check is made to see whether the instrument is arrested; handle 6 of the arresting device should be in the position "away from one's self";

the voltage in the on-board net is checked; it should be at least 24 volts;

the power supply switch of the directional gyro is placed in position "turned on"; the required angle (course) is placed on scale 2 by a smooth turning of handle 6;

the instrument is released, for which handle 6 of the arresting device should be drawn toward one's self up to the click.

It is permitted to begin movement of the vehicle no earlier than 5 minutes after the power supply of the directional gyro has been turned on. Before starting to move, we check to see whether the instrument has been freed, since movement with an instrument which has been turned on and arrested may cause it to break.

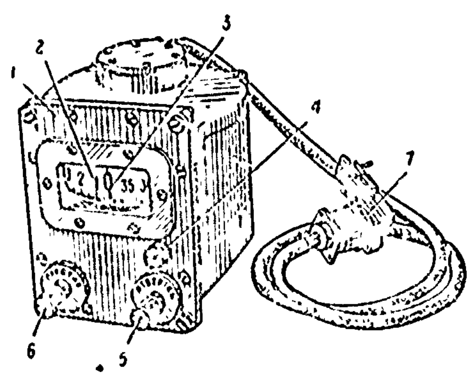


Figure 73. Directional gyro.

1 - plate; 2 - scale; 3 - index; 4 - plug; 5 - turn screw; 6 - handle of arrester; 7 - plug-type connecter.

Turning off the directional gyro: the instrument is arrested (handle 6 is placed in the position "away from one's self") and the instrument's power supply switch is placed in the "off" position.

b) Initial (first) orientation of the vehicle

The initial orientation of the vehicle consists of determining the course (grid azimuth or magnetic azimuth) of the longitudinal axis of the vehicle and is performed by one of the following methods.

The first method is used when it is necessary to accomplish movement along one indicated (selected) direction.

The machine is placed at the start point in such a way that the cross hairs (central mark) of the sighting device is directed at a reference point selected along the course of movement. In this, the turret should be located in the 0-00 (or 30-00) position.

After orientation of the vehicle, the directional gyro is turned on and the value of 0° is placed on the scale of the directional gyro.

The second method for the initial orienting of the vehicle is employed when the directional gyro is used to drive the vehicle in any direction and the grid azimuth of the longitudinal axis of the vehicle can be determined from a map. The operating procedure in this case will be the following:

the vehicle is placed on a terrain point (shown on the map) from which some distant reference point is visible;

on the map, the grid azimuth α_{or} of the line of direction from the terrain point (vehicle) to the reference point is measured with a protractor (chord rule);

the central point of the sighting device of the vehicle is aimed at the distant reference point and the sighting angle α_{sight} is read (if, with the position of the sighting device ahead, the central mark stands at the 30-00 mark, the sighting angle equals the reading to the reference point minus 30-00);

the grid azimuth of the longitudinal axis of the vehicle α_m is calculated from the formula

$$\alpha_m = \alpha_{or} - \alpha_{sight}.$$

The third method for the initial orientation of the vehicle is employed when the directional gyro is to be used for driving the vehicle in any direction but the grid azimuth of the longitudinal axis of the vehicle cannot be determined from a map as in the second method (there are no reference points or reference points cannot be seen). In this case, we determine the magnetic azimuth of the longitudinal axis of the vehicle A_m by the following procedure: we step approximately 50 meters away from the vehicle and, with a compass (or aiming circle) we determine the magnetic azimuth A_{veh} to the center of the turret (or to the sighting device) and then or simultaneously

the sighting device of the vehicle is aimed at the compass (at the place from which the azimuth was measured) and the sighting angle α_{sight} is read. The magnetic azimuth of the longitudinal axis of the vehicle is calculated from the formula

$$A_m = A_{veh} + 30\text{-}00 - \alpha_{sight}.$$

The grid azimuth of the longitudinal axis of the vehicle (or the magnetic azimuth) are placed on the scale of the directional gyro, after which the instrument is released and movement may be begun.

c) Driving the vehicle by directional gyro

Driving the vehicle by directional gyro is accomplished in the same manner as movement by azimuths (see Section 6, Chapter VII).

First, on a map we plan the route and prepare necessary data: grid azimuths and distances or magnetic azimuths and distances (with the third method for initial orientation of the vehicle); the data which are obtained are recorded in a table or recorded on the map (see Section 6, Chapter VII).

With a considerable length of the route (time of movement more than 1.5 hours) terrain points and reference points should be noted for every 1-1.5 hours for repeated orientation of the directional gyro and to prepare necessary data.

Procedure for movement: having completed initial orientation, the vehicle with the directional gyro turned on is driven over to the start point of the route, it is turned in the required direction (the reading which corresponds to the value of the grid azimuth of the first leg of the route is placed on the scale of the directional gyro opposite the index) and we begin movement. During movement, by turns of the vehicle, we hold the corresponding angle under the index and, covering the required distance (the distance is estimated from the speedometer indicator), we turn the vehicle in the direction of the second leg of the route and continue movement further in a similar manner.

If approximately 1.5 hours have already passed since the start of the turning on of the directional gyro, it is necessary to check the orientation of the directional gyro by the method for initial orientation, after which we can continue movement along the route.

2. Orientation with the Use of Navigational Equipment Without a Plotter

a) Basic elements of the equipment

A navigational apparatus without a plotter is intended for determining the location of moving vehicles under conditions of difficult orientation and driving the vehicle over an assigned course.

The instruments of the apparatus assure the continuous development of rectangular coordinates of the position of the moving vehicle and indication of the course of movement; the average error of the development of coordinates is no more than 1.3% of the route which has been covered, the time for preparation for operation is 10-15 minutes, and the time of continuous operation (without reorientation) is up to 3.5 hours.

The kit for the navigational apparatus includes the following instruments: course data unit, control panel, route data unit, coordinator, two course indicators, and a converter.

The course data unit serves to develop the grid azimuth and represents a directional gyro in which a free gyroscope serves as the sensitive element. The course data unit is equipped with various devices. Drift of the main axis of the gyroscope of the course data unit in 30 minutes is no more than ±20 mils.

The course data unit serves for continuous synchronous transmission of the length of the route covered by the vehicle to the coordinator. The course data unit is connected to the running gear of the vehicle by a flexible shaft.

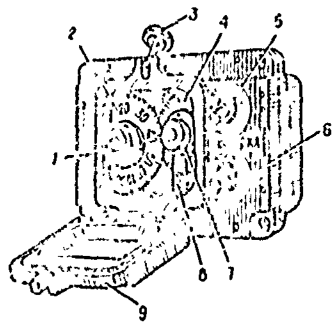


Figure 74. Control panel.

1 - handle of the potentiometer for latitudinal balancing; 2 - scale of the potentiometer for latitudinal balancing; 3 - nut; 4 - scale of the correction potentiometer; 5 and 6 - "converter" and "system" switches; 7 - handle of correction potentiometer; 8 - clip; 9 - lid.

The control panel (fig. 74) is intended for turning on the navigational apparatus and conducting latitudinal balancing of the gyro compass.

There are two switches, "converter" and "system" (see 5 and 6 on fig. 74) on the control panel for turnong on the converter and connecting the system. In addition, a potentiometer for latitudinal balancing (on the scale 2 of the potentiometer the geographic latitude of the terrain is set) and a correction potentiometer (intended for making more precise the balancing of the gyroscope in the process of operation) are also located on the control panel.

The coordinator (fig. 75) is intended for the continuous automatic development of coordinates of the vehicle's position and to indicate the grid azimuth of the longitudinal axis of the vehicle.

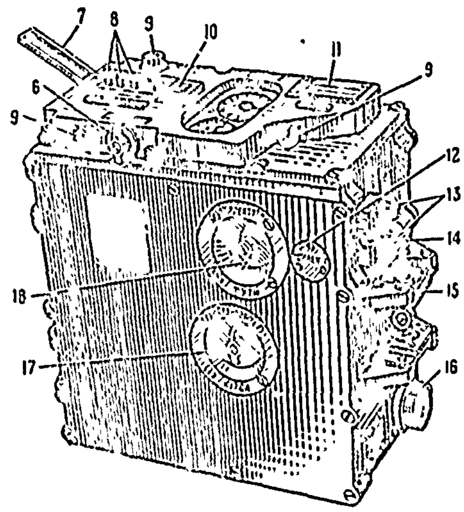


Figure 75. Coordinator.

6 - handle for the switch to set the coordinates; 7 - lid for knobs; 8 - knobs; 9 - holder for illumination bulb; 10 - catch; 11 - plate; 12 - lid; 13 - spare holders for illumination bulbs; 14 - spring clamp; 15 - shock absorber; 16 - plug-type connector; 17 - "set course" knob; 18 - "correct course" knob.

Located on the front panel of the coordinator (fig. 76) are scales 1 and 2 for the reading of coordinates X and Y, scales 3 and 4 "course" (reading of grid azimuth) and scale 5 "course correction."

The setting of the initial coordinates is performed by knobs 8 (see fig. 75) with the corresponding position of knob 6 of the switch for setting coordinates. The knobs are covered by a lid, 7, which is fastened by a catch, 10. Illumination of the scales is provided by bulbs which are located in plastic holders 9. A plate, 11, serves for recording the course and coordinates of the vehicle with a pencil. Located on the front wall of the instrument are a knob 18 for setting course corrections, and knob 17 for setting the initial grid azimuth. Placed beneath the lid 12 is a regulating potentiometer for the amplifier. On the right side wall are spare holders 13 for the illumination bulbs, clamp 14 for a pencil and eraser, plug-type connector 16, and shock absorber 15 for installing the instrument in a vehicle.

The coordinator contains a computer (it serves to calculate the coordinate increments) with receivers for the synchronous transmission of angle and route and a scale mechanism.

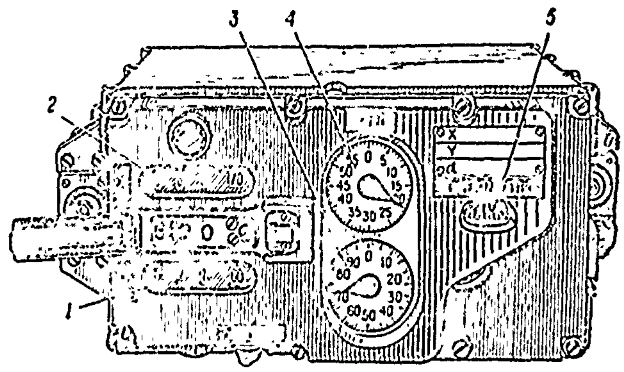


Figure 76. Coordinator (front panel).
1 and 2 - X and Y coordinate scales; 3 and 4 - "course" scales; 5 - "course correction" scale.

The scale mechanism for the coordinates (fig. 77) represents a drum-type counter which permits reading the coordinates which are expressed by five-unit figures. The capacity of the counter is 99,999 meters. The value of one revolution of the drum 1 comprises 100 meters. Numbering is performed every 10 meters; in the gaps between the numbers, the drum is divided into four divisions (the value of a division is 2.5 meters). The values of the revolutions of the drums 2, 3, 4, are 1000, 10,000, and 100,000 meters, respectively. The framing of the X and Y coordinates is performed by the same knobs with the use of the switching mechanism 6.

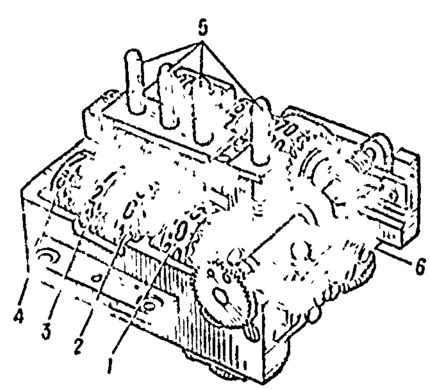


Figure 77. Scale mechanism for coordinates.
1, 2, 3, 4 - scale drums; 5 - knobs; 6 - mechanism for switching the knobs.

The scales for reading the grid azimuth are of the round type with rotating arrows (see fig. 76). The value of one turn of the arrow of the "course" scale, 4, for the coarse reading of the grid azimuth is 6000 (value of a division - 100). The value of a turn of the arrow of the "course" scale 3 for the precise reading of 100 is divided into 100 divisions (value of a division is 1 mil).

The scale for setting route corrections, 5 (see fig. 76) is round, and of the rotating type. On the scale there are 40 divisions with numbering from -12 to +10%, and the value of a division is 0.5%.

The course indicator (fig. 78) is intended for duplicating the readings on the scale of the coarse reading of the grid azimuth on the coordinator and is used in driving the machine along a given course. The scale 2 of the course indicator is divided into 120 divisions (the value of a division is 50 mils). If in the process of movement it is necessary to adhere to a certain course, the index of the moveable ring, 3, is placed manually opposite the corresponding division on the scale. In moving along this course, the arrow 1 of the indicator will be located opposite the index.

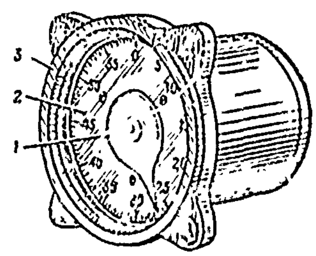


Figure 78. Course indicator.
1 - arrow; 2 - scale; 3 - ring with index.

b) Initial orientation of the vehicle

The initial orientation of the vehicle consists of determining initial data: grid azimuth of the longitudinal axis of the vehicle and rectangular coordinates.

Initial data are determined, as a rule, using a topographic map of a scale of 1:50,000 or 1:100,000 in the following manner. First, an initial point is selected - a terrain object which is depicted exactly on the map and to which the vehicle may drive (crossroad or road fork, bridge, etc.) or right up to which one can drive (geodetic point, tower, etc.). Moreover, from the vehicle which has been placed at the initial point, some reference point should be visible (plant smokestack, lone tree, etc.) which is located no closer than 6 cm from the initial point at map scale.

From the map, the grid azimuth, α_{or}, (see p. 100) of the line from the initial point to the reference point is measured with a chord rule and,

with a measurer, the rectangular coordinates of the initial point are read as accurately as possible (from the transverse scale on the metal ruler).

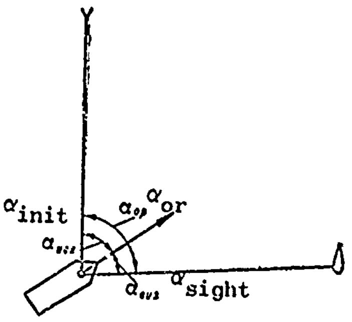


Figure 79. Determination of the grid azimuth of the longitudinal axis of the vehicie.

The vehicles drive up to the initial point in such a way that the angle measuring device of the vehicle (center of the turret) is located above the initial point; if it is impossible to drive on to the initial point, the vehicle is placed as close as possible to the initial point on the line from the initial point to the reference point (fig. 79).

With the angle measuring device of the vehicle (fig. 80) we sight on the reference point and read the angle α_{sight} and then we compute the initial grid azimuth of the vehicle α_{init} from the formula

$$\alpha_{init} = \alpha_{or} - \alpha_{sight}$$

The initial grid azimuth is determined as accurately as possible, since the accuracy of orientation in the future depends to a considerable degree on it.

To check the correctness in determining the initial grid azimuth, it should be determined, as a rule, from two reference points. The grid azimuths which are determined from the first and second reference points should not differ by more than 4 mils. For the final value, the mean arithmetic value of the two determinations should be taken.

In the case where the grid azimuths differ by more than 4 mils, all measurements and computations should be repeated; if the error is not found, it is necessary to determine the grid azimuth from a third reference point. If, even in this case the grid azimuths do not agree, the initial point is changed and all actions are again repeated.

On closed terrain and at night when distant reference points are not visible, the initial grid azimuth is determined by aiming circle in the following manner.

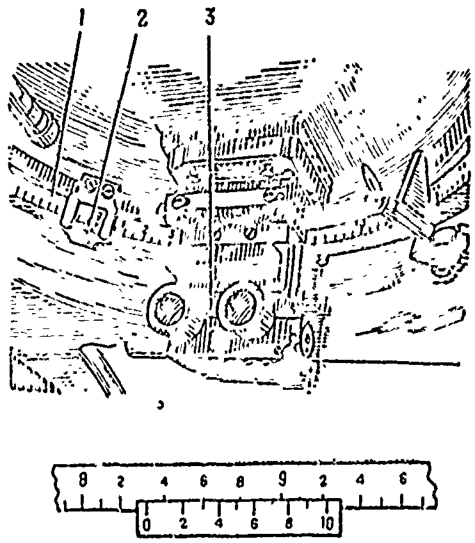


Figure 80. Angle measuring device.
1 - main scale; 2 - reading scale; 3 - optical sight.

The aiming circle is set up (fig. 81) at a distance of at least 50 meters from the vehicle and oriented by the magnetic needle; the tube of the aiming circle is laid on the optical sight of the angle measuring device of the vehicle and the azimuth of the magnetic line of direction from the aiming circle to the vehicle is read from the aiming circle scale while the angle to the aiming circle is measured with the angle measuring device of the vehicle.

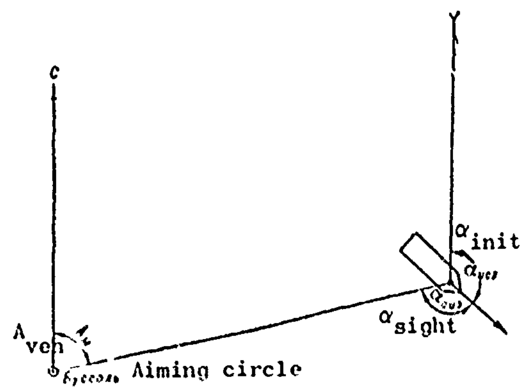


Figure 81. Determining the grid azimuth of the longitudinal axis of the vehicle using an aiming circle.

The initial grid azimuth is calculated from the formula

$$\alpha_{init} = A_{veh} + \Pi + 30\text{-}00 - \alpha_{sight},$$

where

A_{veh} is the azimuth of the magnetic line of direction from the aiming circle to the vehicle;

Π is the correction for direction (taken from a map);

α_{sight} is the angle between the line of direction of the longitudinal axis of the vehicle and the line of direction to the aiming circle.

c) Preparation of the navigational instrument for operation

The navigational instrument may be turned on only when the vehicle is stationary, and in the following sequence:

1. The voltage of the on-board net is checked (it should be at least 24 volts).

2. The power supply for the converter is turned on by the "converter" switch on the control panel (in this, the converter is started up and the bulb for illuminating the coordinator burns).

3. After 10-12 minutes from the moment that the converter is turned on, the "system" switch is placed in the "on" position (in this, the receiver of the synchronous transmission of the angle occupies a coordinated position with the data unit and the arrow of the "course" scale occupies the corresponding position).

The input of initial data is performed after the equipment has been completely turned on in the following order:

beginning (initial) coordinates;

initial grid azimuth;

route correction factor.

In order to put in the coordinates, one should:

turn the handle of the coordinate setting switch in the "X" or "Y" position, depending on which coordinate is being inserted;

press the button until the setting (appearance) of the required numbers; in this, see that the numbers are placed in the middle of the window;

release the handle of the coordinate setting switch and close the lid.

The input of the initial grid azimuth is performed by the "course" handle (see fig. 75) and the route correction factor is set with the "route correction" handle. The route correction setting must be performed only in a direction from minus values to plus values in order to exclude backlash of the kinematic chain.

The route correction factor is determin d by a preliminary passage over the route for a length of up to 1000 meters or is established in accordance with data obtained from the experience of previously accomplished trips over similar roads.

After the values for the inidial data and route correction have been set, movement can begin.

d) Turning off navigational instruments

The navigational instrument is turned off only when the vehicle is stationary and in the following sequence:

the "system" switch on the control panel (see fig. 74) is moved to the "off" position;

the "converter" switch is placed in the "off" position.

Movement of the vehicle may be begun after the apparatus has been turned off only after the gyroscope of the course data unit has come to a complete stop (15-20 minutes are required for the rotor of the gyroscope to stop).

e) Procedure for orienting in motion

A topographic map is prepared ahead of time, before the start of movement; the required sheets are pasted together, the route is highlighted, and necessary data are prepared (see p. 175).

In addition, to check the accuracy of the apparatus' operation, coordinates of individual reference points and grid azimuths of lines of direction of individual straight line road sectors are determined. The operation of the apparatus is checked from these data and, in necessary cases, corrections are applied to the apparatus without repeated orientation (see p. 194).

With a considerable length of the route of march (3.5 hours of movement or more), where possible terrain points and reference points should be selected in areas of halts for reorientation of the apparatus and the preparation of necessary data.

With movement along roads during daytime and with a sufficient conformance of the map to the terrain (the correction of the determination of one's position causes no doubt) orientation is conducted in the normal manner - by map. In case of doubt in the correctness of movement (the next reference point has not been discovered), the x and y coordinates are read from the coordinate scale and the location of the vehicle is found (elaborated) on the map and then the direction for further movement is noted.

In moving off roads, particularly with poor visibility (at night, in fog, etc.), as well as with actions in areas of mass destruction and other cases which hinder orientation, it is accomplished as a rule with the complete utilization of all instruments of the navigational apparatus in the following order:

the map is prepared as indicated above and, in addition, along the entire route grid azimuths and distances necessary for driving the vehicle by the course indicator are determined and marked down on the map;

the required course and distance are indicated to the driver and the latter drives the vehicle with the use of the course indicator and speedometer;

after 10-20 minutes of movement, as well as at all points where the route turns, the position of the vehicle is determined on the map from the coordinates read from the coordinate scale and, where necessary, the direction for further movement is defined more precisely.

f) Special features in using the navigational apparatus at a junction of zones

If the route crosses a junction of zones of topographic maps, then the vehicle is reoriented by the initial orientation method with the passage of the vehicle into the adjacent zone, and the new coordinates and course which correspond to the coordinate system of the given zone are inserted into the navigational apparatus.

In those cases where reorientation of the vehicle in crossing the junction of the zones is impossible because of the situation, the use of a navigational apparatus without a plotter has the following special features:

in preparing the map for work with the apparatus (see above) an additional coordinate grid (see p. 105) which corresponds to the coordinate grid of the map over which the initial orientation of the vehicle was performed, is drawn on the map sheets of the adjacent zone;

in moving along a route which passes over the map sheets of the adjacent zone, the location of the vehicle and course of movement are determined from the additional coordinate grid;

reorientation of the vehicle is performed when the situation permits (but no later than 3.5 hours after the apparatus has been turned on); after the reorientation of the vehicle, its location and course of movement are determined from the main coordinate grid (which is completely printed on the map).

3. Orientation with the Use of a Navigational Apparatus with a Plotter

a) Basic elements of the apparatus

The instruments of the navigational apparatus with a plotter assure the continuous generation of coordinates of the vehicle's position, indication of course of movement, and the plotting of the route which has been covered on a map.

The navigational apparatus equipment kit includes the following basic instruments: course data unit, route data unit, course plotter, converter, motor generator.

The course data unit (fig. 82) which is the gyroscopic course pointer (directional gyro) is intended for working out the grid azimuth. The drift of the main axis of the gyroscope of the course data unit should be no more than ±20 mils per hour.

The course data unit serves for the continuous synchronous transmission of the length of the route covered by the vehicle to the course plotter.

The course plotter (fig. 83) serves for the continuous automatic generation of the coordinates of the vehicle's location, indicating the grid azimuth of the vehicle, and drawing the route of movement on a map. The course plotter includes a computer, and scale and plotting mechanisms.

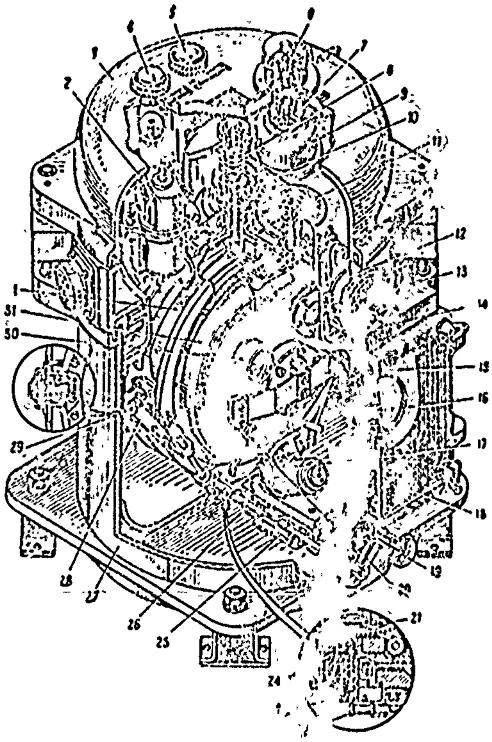


Figure 82. Course data unit.

1 - outer gyroscope ring; 2 - sine-cosine rotating transformer; 3 - lid; 4 and 5 - signal lamps "lock" and "braking"; 6 - course setting handwheel; 7 - coupling device; 8 - rotating contact devices; 9 - electric motor; 10 and 11 - scales; 12 - lighting switch; 13 - window; 14 - housing; 15 - temperature compensator; 16 - mirror; 17 - electric motor; 18 - door; 19 - lock handle; 20 - connecting branch; 21 - segment; 22 - cog; 23 - pin; 24 - lock; 25 - contacts; 26 - shaft; 27 - housing; 28 - link gear; 29 - pivot; 30 - vacuum gauge; 31 - gyro chamber.

The computer provides the computation of the increase in the coordinates; it consists of a sine-cosine plotter, multiplying mechanisms, the route correction mechanism, and a number of gears.

The scale mechanism serves to set and read the values of coordinates, grid azimuth, route, map scales, and route corrections.

The x and y coordinates of the vehicle are established and read from the coarse reading scales 20, 18 (value of division 1000 meters) and the fine reading scales 23, 24 (value of a division 5 meters).

The grid azimuth is established and read from the coarse reading scale 17 (value of a division 100 mils) and fine reading scale 26 (value of a division 1 mil).

The path covered by the vehicle is read from the coarse reading scale 21 (value of division 100 meters) and fine reading scale 22 (value of division 1 meter).

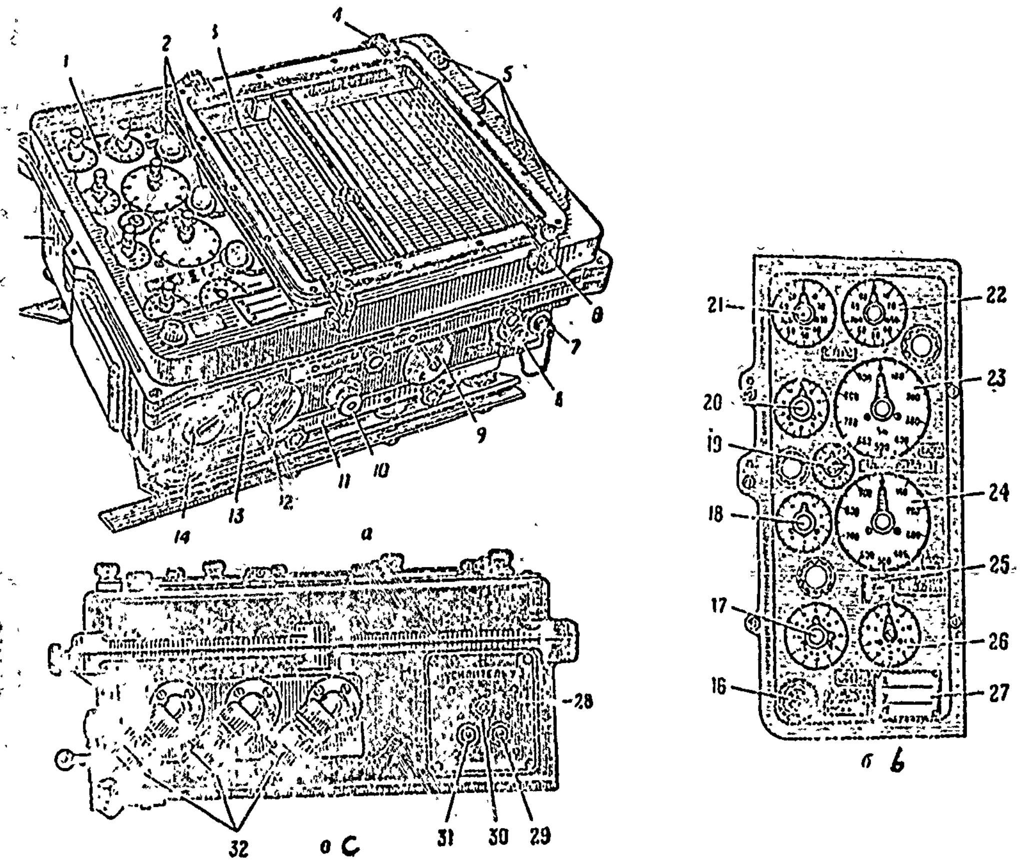


Figure 83. Course plotter.

a - general view; b - scale panel; c - right side panel; 1 - scale plate; 2 and 5 - scale illumination lights; 3 - protective glass for the plotting board; 4 - spring clamp; 6 - hinged screw; 7 - route switch; 8 - illumination rheostat; 9, 12, 14 - handwheels; 10 - handle for setting route correction; 11 - spare plotting board; 13 - scale switch handle; 15 - housing; 16 - signal light; 17-26 - scales; 27 - strip; 28 - amplifier; 29 and 31 - potentiometers; 30 - amplifier switch; 32 - plug-type connector.

The scale of the map being used is established from scale 25 on which there are five marks: 1:100,000, "off", 1:25,000, "off", 1:50,000.

The value of the route corrections is set by scale 19, the scale is divided into 110 divisions with a value of a division of 0.2%. On this scale, 60 divisions have an engraving in a black color and marked with "plus" sign. The slipping of the vehicle is established from this portion of the scale. The remaining 50 divisions are etched in red and marked with a "minus" sign. The sliding of the vehicle is established by this part of the scale.

The plotting mechanism serves to draw the path of the vehicle's movement on maps of scales of 1:25,000, 1:50,000, and 1:100,000. The maps are fastened to a plotting board (fig. 84) of the course plotter by lamellar springs 2.

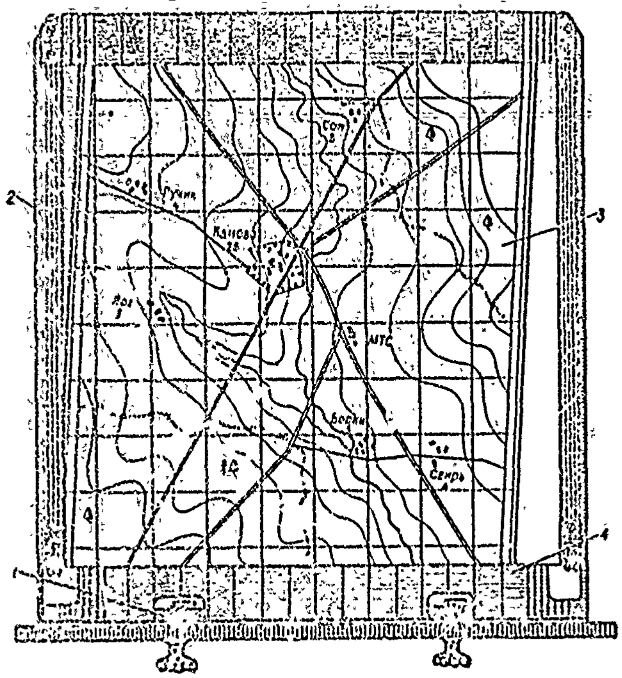


Figure 84. Plotting board with map.
1 - catch; 2 - spring; 3 - map; 4 - plotting board.

The converter is intended for the conversion of the direct current of the on-board net of the vehicle to a three-phase alternating current for feeding the course data unit with three-phase current. The converter (fig. 85) is mounted on a panel, 1, and located here is the handle 4 of the phase switch which can occupy one of three positions, "off," "on," and "brake."

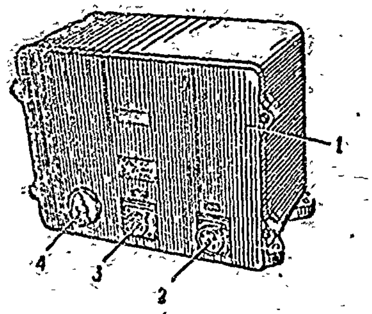


Figure 85. Converter.

1 - panel; 2 - plug-type connector; 3 - collar; 4 - phase switch knob.

The motor generator is intended for the conversion of the direct voltage of the on-board net of the vehicle to alternating single-phase current for the feeding of the synchronous transmission of angle and route with this voltage.

b) Overall procedure for orientation

Orientation with the use of the navigational apparatus with a plotter includes the following basic processes:

The first (initial) orientation of the vehicle (accomplished by the method of initial orientation of the vehicle equipped with a navigational apparatus without a computer, see p. 186);

preparation of the navigational apparatus for operation;

work with the navigational apparatus on route.

c) Preparation of the navigational apparatus for operation

The navigational apparatus may only be turned on with the vehicle in a stationary position and in the following sequence.

1. Before turning on the apparatus, the following are checked:

the setting of knob 4 (see fig. 85) of the phase switch on the converter (the phase switch should be in the "off" position);

the position of knob 19 (see fig. 82) of the locking mechanism of the gyro course pointer (the knob should be in the "lock" position);

the vacuum in the chamber of the gyro motor by the vacuum gauge (the vacuum should be at least 70 divisions);

the voltage of the on-board net of the vehicle (voltage should be 27 ± 2.7 volts).

2. The knob, 4 (see fig. 85) of the phase switch is placed in the "on" position.

3. The "amber" switch is used to turn on the power of the converter (in this, the converter is started and the "stop" signal lamp on the gyro course pointer lights up).

4. After 5 minutes from the moment the converter has been turned on, the gyro chamber is removed from the lock (in this, the signal lamp "stop" is extinguished).

5. After 10 minutes, the power supply of the motor generator is turned on by the "trace" switch.

6. Switch 30 (see fig. 83c) on the amplifier panel of the course plotter is placed in the "on" position.

7. The "route switch", 7 (see fig. 83a), on the course plotter is moved to the "on" position.

8. The required brightness of illumination of the scales and map is established by the "lighting" rheostat 8 (see fig. 83a).

The input of initial data is performed by the corresponding devices. In this, it is necessary:

to place the map on the plotting board and to install the latter in the course plotter;

to place (insert) the beginning (initial) coordinates;

to set the route correction factor.

The map is placed on the plotting board in the following manner:

the edge of the map is bent to conform to the size of the plotting board in such a way that edges remain for fastening them with the lamellar springs and the numbers of the markings of the coordinate grid are visible;

the map is placed on the plotting board in such a way that its northern part is at the top and the vertical lines of the map grid coincide with the lines on the plotting board or are parallel to them; in this position, the map is fastened with the lamellar springs (see fig. 84) and the plotting board is installed in the course plotter.

The input of initial coordinates on the scales of the course plotter is combined with the placing of a pencil at the initial point on the map and is performed in the following sequence:

the "scales switch" knob 13 (fig. 83a) is placed in the position which corresponds to the scale of the map;

by means of the "X" 12 and "Y" 9 handwheels (see fig. 83), the pencil is placed exactly in the southwest corner of the square in which the initial point is located;

on the coarse reading coordinate scales "X" 20 and "Y"18 (see fig. 83b) the numbering values of the kilometer lines, at the intersection of which the pencil is placed, are set by means of wing nuts, and zero readings are placed on the fine reading scales 23 and 24;

the hundreds, tens, and units of the coordinate values of the initial point are placed on the fine reading scales by means of handwheels "X"12 and "Y" 9 (see fig. 83a); as a result of this operation, the pencil is moved to the initial point on the map and the coordinates of the initial point will be placed on the scales.

If the coordinates of the initial point were not determined ahead of time, the input of the initial coordinates and the setting of the pencil on the initial point are performed in the following manner:

the pencil is placed exactly in the southwest corner of the square in which the initial point is located by rotating the "X" and "Y" handwheels;

the numbering of the kilometer lines of the square is placed on the coarse reading scales by the corresponding wing nuts and zeros are placed on the fine reading scales;

by rotating the "X" and "Y" handwheels, the pencil is moved to the initial point on the map; as a result of this operation, the values of the coordinates of the initial point will be obtained on the coordinate scale (the handle for the "scale switch" should be in the position which corresponds to the scale of the map on the plotting board).

The initial grid azimuth is set (inserted) on the coarse reading scale 17 and the fine reading scale 26 (see fig. 83b) from the arrow and numbering in black by rotating the "course" handwheel 14 (see fig. 83a).

The value of the route correction is set from scale 19 (see fig. 83b). After the initial data have been inserted, movement can be begun.

d) Work with the navigational apparatus en route

The sheets of a topographic map of a scale of 1:100,000 or 1:50,000 are selected for the route ahead of time; the sheets are numbered in the order in which they are placed on the plotting board of the course plotter.

If the route crosses the junction of zones, then an additional coordinate grid is drawn on the sheets of the maps of the adjacent zone which corresponds to the coordinate grid of the map from which the initial orientation of the vehicle was performed.

The route is easily highlighted (by a light tone of a colored pencil) and, along the route, we determine and record on the map the coordinates of individual reference points (road intersections, bridges, etc.) and the grid azimuths of straight sectors of the route. The operation of the apparatus is checked by these data and, where necessary, the course and coordinates are corrected (defined in detail) on route. In refining the coordinates which are worked out by the apparatus, the coordinates of the reference points towards which the vehicle moves are placed on the "X" and "Y" scales.

The correctness of the course worked out by the apparatus is judged from the angle of deviation of the trace (the line drawn by the pencil of the apparatus) from the line of direction of a straight road.

The size of the course correction may be determined approximately having established the number of millimeters that the pencil deviates from the road in a distance of 1 km. For example, with a deviation of the pencil from the road of 1 mm on a 1:100,000 map, the correction in grid azimuths

will be 100 mils. The course correction is applied by the "course" handwheel, in which respect, if the pencil deviates to the right of the road (in accordance with its direction of movement), the grid azimuth should be reduced by the size of the correction and, with a deviation to the left increased.

At control reference points, the value of the route correction factor is also defined in detail simultaneously with the refinement of the coordinates. If the vehicle moved toward a reference point and the pencil moved beyond this reference point on the map, it is necessary to increase the route correction coefficient somewhat while, if the pencil did not reach the check reference point, it should be reduced.

During movement, we follow the position of the pencil and the "turn off plotting" signal light 16 (fig. 83b). When the pencil approaches the edge of the plotting board, the signal light lights up; after this, movement can be continued for no more than 1 cm at map scale and then it is necessary to change the map.

The replacement of the map is performed in the following order:

the "scales switch" knob 13 (see fig. 83a) is placed in the "off" positition when the pencil approaches the edge of the map, and we continue movement along the route somewhat beyond the limits of the map sheet being replaced;

the vehicle is stopped and the coordinates and grid azimuth read from the "X," "Y," and "course" scales are written down;

the plotting board is removed from the course plotter and the spare plotting board with the next map is installed in its place;

the pencil is placed at the point where the vehicle has stopped; in accordance with the coordinates which have been recorded, the recorded value of the grid azimuth (if it has not been changed) is restored on the "course" scales. Placing the "scales switch" knob in the position which corresponds to the map scale, we can continue movement.

In replacing a map at the junction of zones, the next map sheet is placed on the plotting board in such a way that its vertical lines coincide with the vertical lines of the additional coordinate grid on the map sheet which is being installed.

When installing a map sheet by the additional grid, the pencil will indicate correctly the route on the map but the value of the coordinates and grid azimuth will be worked out in the system of the zone in which the initial orientation was performed. The operation of the equipment in the new coordinate system is completely changed over by the method of initial orientation when the situation permits.

In the process of movement, orientation (maintaining the route and coming out at the assigned area) is accomplished by being guided by the position of the pencil on the map of the course plotter.

e) Turning off the apparatus

The apparatus is turned off completely only when the vehicle is in a stationary position and in the following sequence:

the illumination of the scales and map is turned off by the "lighting" rheostat 8 (see fig. 83a);

the "route switch" 7 and amplifier switch 30 are placed in the "off" position;

the "trace" switch is moved to the "off" position;

the gyro chamber is placed on lock (the "lock" light should light up);

the gyro chamber is turned by the course setting handwheel in such a way that the window 13 (see fig. 82) on the chamber of the gyro motor is visible;

the "amber" switch is placed in the "off" position;

the phase switch is moved to the "brake" position;

the "amber' switch is placed in the "on" position (the "brake" signal light on the gyro course pointer should light up);

in the mirror on the door of the gyro course pointer, the rotor of the gyroscope is observed through the small window in the chamber; when the rotor has stopped, the "amber" switch is placed in the "off" position;

the phase switch is placed in the "off" position.

The time for braking the gyroscope, from the moment it is turned off to braking, is on the order of 4-5 minutes. If, because of the situation the vehicle cannot be stopped, the apparatus is partially turned off; the gyro course pointer is not switched off.

Chapter IX

Reconnaissance and Reconnoitering of the Terrain

1. Simple Methods for Measuring (Determining) Angles on the Ground

a) Approximate (visual) determination of angles on the ground

The essence of the method consists of comparing the measured angle with a known angle, most often a right angle. The right angle may be constructed (laid out) on the ground:

as the angle between a line of direction of a sighting directly ahead and a hand raised to the side;

as the angle of view with alternate viewing across the bridge of the nose - with the left eye to the right and the right eye to the left (from experimental data, the size of this angle varies from 90 to 100° with different people);

by constructing a triangle with a relationship of the sides of three, four, and five; the angle opposite side "five" will be a right angle (90°), that opposite side "four," will approximately equal 55°, and opposite side "three" 35°.

An angle of 6° (approximately) is formed by the rays of sight if we sight at the end of the index finger of a hand extended in front by the left and right eyes in turn.

b) Measurement of angles with binoculars

To determine the angle between lines of direction to two objects, it is necessary to match the extreme mark on the binocular reticule with one of the objects, to count the number of divisions to the second object, and to multiply the obtained number by the value of a division. The value of a small division in the angle-measuring reticule of the binoculars equals 5 mils (0-05), and of a large division, 10 mils (0-10).

c) Determining angles using a ruler with millimeter divisions

To obtain angles in mils, the ruler must be held in front at a distance of 50 cm from the eyes and, matching one of the lines on the ruler with some object, count the number of millimeter divisions to the second object (fig. 86); the result is multiplied by 2. This will also be the size of the angle in mils since 1 millimeter division at a distance of 50 cm corresponds to an angle of 2 mils.

To obtain the result in mils, the operating procedure is similar to that presented but the ruler must be held at a distance of about 60 cm from the eyes. Then, 1 mm on the ruler will correspond to 6', while 1 cm will correspond to 1°.

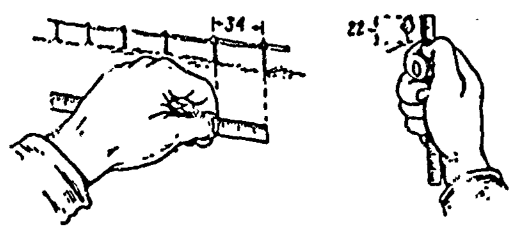


Figure 86. Measuring angles with a ruler.

2. Simple Methods for Determining Distances (Widths) of Obstacles on the Terrain*

a) Visual determination of distances

The essence of the method is comparing the distance to be determined with one that is known or registered in the memory. The accuracy of the visual method depends on the experience of the performer, observation conditions, and the size of the distance being determined. In determining distances up to 1 km, the error fluctuates within limits of ±10-20%, while with large distances errors will be so great that as a practical matter, visual determination of them is inexpedient.

Observation conditions affect the visual determination of distances in the following manner:

larger objects appear to be closer than those which are similar but which have smaller dimensions;

objects of a bright color (white, yellow, red) appear to be closer than dark objects (black, brown, blue);

lightly illuminated and easily visible objects seem to be closer than those which are darkened (in shadow, dusk, and fog) and which merge with the background in color; on cloudy days, objects appear to be more distant;

the smaller the objects on the sector being determined (when observing across an expanse of water or in the steppe), the smaller the distance appears to be;

folds in the terrain which cross the line being measured hide the visible distance;

when observing in a prone position, objects appear to be closer than when observing in a standing position;

when observing from bottom to top (toward the summit of an elevation) objects appear to be closer and when observing from top to bottom, farther.

* In solving the problem for determining distances, it should be kept in mind that it is possible to make wide use of range finders of various types, operations with which are presented in the special instructions which are applicable to them and are not considered here.

b) Distances of visibility (differentiation) of various objects by the unaided eye

Table 41

Objects and indicators	Distances, km
Populated places	10-12
Large structures	8
Plant smoke stacks	6
Separate small houses	5
Windows in houses (without pieces)	4
Chimneys on roofs	3
Airplanes on the ground, tanks at the halt	1.2-1.5
Trunks of trees, poles for communication lines, people (in the form of points), wagons on the road	1.5
Movement of the foot and hand of a walking person	0.7
Heavy machine gun, mortar, antitank gun, stake for barbed wire obstacles, sashes of frames in windows	0.5
Light machine gun, rifle, color and parts of clothing, oval of face	250-300 meters
Tile on roofs, leaves of trees, wire on stakes	200 meters
Buttons and buckles, details of a soldier's armament	150-170 meters
Features of the face, fists, parts of small arms	100 meters
Eyes of a person in the form of a point	70 meters
Whites of the eyes	20 meters

c) Distances of audibility of sounds

Table 42

Sound source	Distance from which heard, km
Firing of an artilllery battery	6
Firing of individual guns from indirect firing positions	3
Automatic firing of large caliber machine guns	3
Automatic firing of heavy machine guns	2
Single round from a rifle	1.2
Movement of tanks (uninterrupted metal rattle of tracks, sharp noise of engines):	
Over a highway	4

(Table 42 cont.)

Sound source	Distance from which heard, km
Over a dirt road	2
Movement of artillery with tractor prime movers:	
Over a highway	3
Over a dirt road	2
Movement of wheeled vehicles (even noise of operation of engines):	
Along a highway	2
Over a dirt road	1
Movement of infantry in dismounted formation (even, dull noise):	
Over a highway	0.6
Over a dirt road	0.3
The snap of falling trees	0.8
The cutting of a forest, ax blows	0.3
Conversation	0.2
Conversation, can understand words	75 meters
Coughing	50 meters
Footsteps	30 meters

d) Determining distances from the sound and flash of a shot (burst)

The determination of distances is based on the difference in the speeds of propagation of light and sound.

Distance is determined from the formula

$$D = t \cdot 330,$$

where

D is the distance to a firing gun (burst), meters;

t is the time from the instant of the flash of the round (burst) to the moment that the sound of the round (burst) is perceived, seconds;

330 is the speed of propagation of sound, meters per second.

The described method can also be used to determine distances to any visible and audible object: operating assembly, nuclear burst, etc.

e) Determining distances from the angular value of known objects

The distance to observable objects can be determined by measuring the angular sizes of these objects or the angular distance between them with subsequent computation by the formula

$$D = 1000 \cdot V/U,$$

where

D is the distance to be determined;

V is the known size of the object or the known distance between the objects;

U is the observed angular size of the object or distance between the objects.

Example 1. A tank can be seen with binoculars; the tank's height is known and equals 2.5 meters; it covers one division (0-05) of the vertical scale. The distance to the tank equals

$$D = 1000 \cdot 2.5/5 = 500 \text{ meters.}$$

Example 2. Distance between telegraph poles equals 50 meters, is covered by 25 millimeter divisions of a ruler, which is 50 cm from the eye, and corresponds to an angular value of 0-50. The distance to the telegraph line equals

$$D = 1000 \cdot 50/50 = 1000 \text{ meters.}$$

f) The dimensions of some objects which are used for determining distances

Table 43

Designation of objects	Dimensions, meters		
	Height	Length	Width
Substantial residential house, one-story	4.0-4.5	-	-
Industrial structure, one-story	5-6	-	-
One-story wooden house with roof	7-8	-	-
Distances between communication line poles	-	50-60	-
Wooden communication line pole	5-7	-	-
Average-age forest	18-20	-	-
2-axle passenger RR car (local traffic)	4.0	14	2.75
Multi-axle passenger RR car (including all metal)	4.25	24-25	2.75
Freight cars:			
2-axle	3.8	7.[illegible]	2.75
multi-axle	4.0	13.6	2.75
RR tank cars:			
4-axle	3.0	9.0	2.75
2-axle	3.0	6.75	2.75
RR flatcars:			
4-axle	1.6	13.0	2.75
2-axle	1.6	9.2	2.75

(Table 43 cont.)

Designation of objects	Dimensions, meters		
	Height	Length	Width
Wheeled vehicles:			
cargo	2	5-6	2-2.5
light	1.5-1.8	4.0-4.5	1.5
Tanks (without gun)	2.2-3.0	5.0-8.0	2.0-3.5
Armored personnel carrier	up to 2	5-6	2.0-2.4
Heavy large-caliber machine gun	0.75	1.65	0.75
Heavy machine gun	0.5	1.5	0.75
Motorcyclist on motorcycle with sidecar	1.5	2.0	1.2
Person of average height	1.65	-	-
Average length of extended arm	-	0.6	-
Average pace of a person	-	0.75	-
Sapper shovel (large) with handle	-	1.10	-
Infantry shovel (small) with handle	-	0.5	-
Blade of infantry shovel (small)	-	0.18	0.15
Distance between ends of thumb and little finger (spread)	-	-	0.2
Matchbox	17 mm	38 mm	55 mm
Diameter of 10 kopek coin	-	-	17 mm
Diameter of 15 kopek coin	-	-	20 mm
Diameter of 20 kopek coin	-	-	22 mm
Diameter of 5 kopek coin	-	-	25 mm

g) The geometric method for determining the width of an obstacle

One of the geometric methods may be the following:

on a sheet of cardboard or paper, we draw an isosceles right triangle abc (fig. 87);

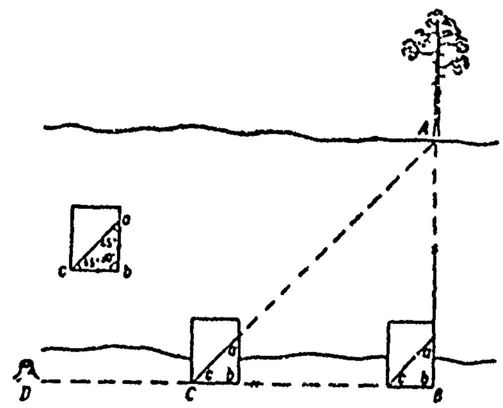


Figure 87. Geometric method for determining the width of an obstacle.

we stand at point b on the bank of the obstacle and orient the figure which has been constructed with the leg ba along the direction BA on the ground; we note a reference point along the line of direction of leg bc (line of direction BD);

moving along the line of direction BD, we find point C from which the leg of the triangle cb and the hypotenuse ca will coincide simultaneously with the corresponding lines of direction CB and CA on the ground. The triangle ABC which is obtained on the ground in this manner will be similar to triangle abc and, consequently, BC equals AB. Having measured the distance BC, we obtain the width of the obstacle.

3. Determining the Height of Inaccessible Objects

a) Determining the height of an object from its shadow

The height of an object can be determined from its shadow by the formula

$$H = Dh/d,$$

where

H is the height of the object;

D is the length of the object's shadow;

h is the height (size) of a man;

d is the length of the shadow of a man.

b) Determining the height of an object from its angular size in mils

The determination is performed from the formula

$$H = DU/1000,$$

where

H is the height of the object being determined;

D is the distance to the object;

U is the angular size of the object in mils.

Example. D = 100 meters, U = 3-00.

$$H = 100 \cdot 300/1000 = 30 \text{ meters.}$$

c) Determining the height of an object from angle and distance

The height of an object above the level of the eye (instrument) is determined from the formula

$$H = D \cdot \tan \alpha,$$

where

H is the height of the object to be determined;

D is the distance to the object;

α is the angle of elevation which is measured to the top of the object.

With the position of the eye (instrument) above or below the base of the object, the height of which is being determined, this difference is added accordingly to the result which has been obtained or is subtracted from it. The size of the value tan α is taken from Table 51 (see p. 240).

4. Determining Steepness of Slopes

a) Determining the steepness of a slope by pacing measurement

The steepness of a slope in degrees is determined from the formula

$$\alpha^\circ = 60/n,$$

where

n is the number of pairs of paces from the point where one is standing to point C on the slope (on the rise), which is located at eye level (fig. 88); this point is found by sighting across a flat object located in a horizontal position in front of the eyes.

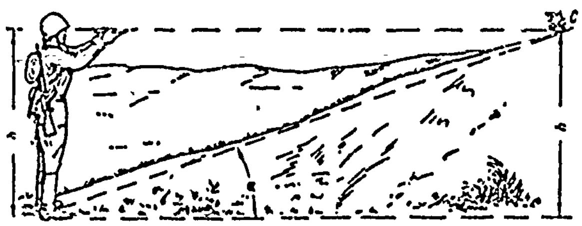


Figure 88. Determining the steepness of a slope by pacing measurement.

In measuring a slope by pacing, the pace should be somewhat increased in comparison with the normal step and the pair of paces should be equal to the height of the measurer up to his eyes.

This method is approximate and may be used for determining the steepness of slopes of no more than 20-25°.

The steepness of a slope may be determined approximately by comparing it with known angles as shown in Figure 89.

Determination of grades of roads in percent is performed from the formula

$$i = h/L \cdot 100,$$

where

i is the road gradient, percent;

h is the height of the determiner up to the eyes, meters;

L is the distance from the determiner to the intended point on the slope which is located at eye level, meters.

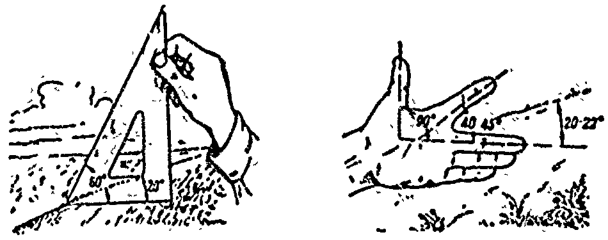


Figure 89. Determining the steepness of a slope by comparison.

b) Measuring the steepness of a slope by protractor

For measuring the steepness of a slope, it is necessary:

to fasten a thread with a weight (plumb bob) to the center of the protractor;

to sight along the line of the base of the protractor to the object which is equal to the height of the observer up to his eyes and disposed higher or lower along the direction of the slope;

to read the angle between the index of 90° and the plumb bob thread.

5. Procedures for Mapping (Plotting on a Map) Various Objects

a) Plotting an object on a map by direction and distances

Operating procedures:

stand facing the direction of the object to be mapped;

orient the map;

find your location on the map;

place a ruler against your location, simultaneously directing it toward the object to be mapped, and draw a line;

lay off the distance to the object from your location at map scale along the line of direction which has been drawn.

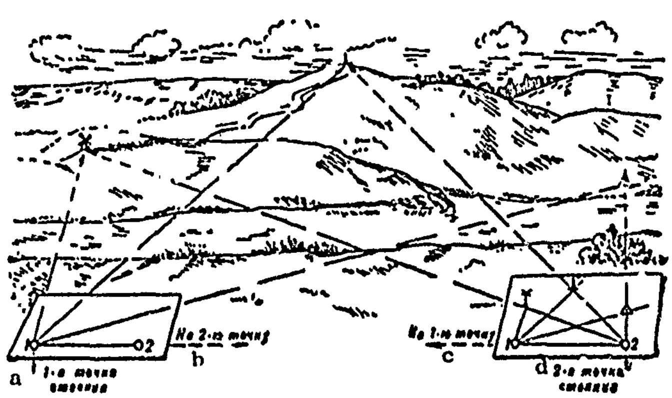


Figure 90. Plotting objects on a map by direct intersection.

a - first location of observer; b - to second point; c - to first point; d - second location of observer.

The point which is obtained will be the desired point.

When a graphic solution of the problem is impossible (if the terrain is under enemy observation, in rain, in a strong wind) it is solved in the following manner. We measure the azimuth, then convert it to a grid azimuth, and draw the line of direction to the object on the map along this azimuth. Subsequently. we perform the same actions as with the graphic solution.

b) Plotting an object on a map by the direct intersection method

To solve the problem by this method, it is necessary to select two points on the ground which are designated on the map, which are accessible to the observer, and which assure visibility to the object being determined.

Standing at point 1 (fig. 90) orient the map and draw a line of direction from own location to the object being determined; perform the same from point 2. The intersection of the lines of direction will determine the location of the object on the map. The angle of intersection of the lines of sight should be at least 30° and no more than 150°.

In the case where the object to be determined is located on a terrain line which is designated on the map, it is sufficient to perform the intersection from one point. The intersection of the line of sight with the terrain line on which the object is located will provide the desired point.

If a graphical solution of the problem is impossible because of weather conditions or the combat situation, it is necessary to measure from points 1 and 2 the azimuths of the lines of direction to the point being determined, convert them to grid azimuths, and draw the lines of direction on the map from the corresponding points. The intersection of the straight lines will determine the location of the objects being surveyed on the map.

6. Elaborating the FEBA on a Map

In the absence of reference points (on closed terrain, with great changes which have occurred on the ground since the moment of survey) the direct determination of the location of the FEBA on the map will often be difficult. In such cases, the problem may be solved using aerial photos or one of the methods described below.

On open terrain. In the depth of the friendly disposition area, two points are selected (base points) which are dependably identified on the map and from which some natural or artificial reference points close to the FEBA or directly on it can be seen. The reference points may be set out especially for this and, in individual cases, signals which are given at a specific time may be used as reference points – flares, bursts of tracer bullets.

The reference points (points from which the signals are given) are plotted on the map by direct intersection from the selected base points.

Subsequent work in elaborating the FEBA is accomplished from auxiliary reference points which are obtained in the normal manner.

If three reference points can be seen from several accessible points on the FEBA, the position of these points may be determined by resection (see Par. 5, Chapter VII).

On closed terrain. Elaboration of the FEBA on closed terrain with the absence of objects which assure direct orientation is accomplished, as a rule, by traverse. Under combat conditions, it is most convenient to run an azimuth traverse. For this, we accomplish the traverse toward the FEBA from a point which is firmly identified on the map (reference point) within the friendly troops dispositions (in the rear) and them, along it (along a trench) and we complete it by tying in to another firmly identified reference point. Movement is accomplished over straight line sectors, measuring and recording azimuth and the length of each sector (by tape, pacing, rangefinder). From the azimuths (with their conversion to grid azimuths) and the distances, after the passage of each individual sector or the entire route the traverse should be plotted on a map.

The tie-in to the second reference point is performed to check the correctness of the plotting of the FEBA, as well as to increase the accuracy of the work by distributing the error which has been obtained over all points and traverse legs.

7. Correcting and Supplementing the Map

The check of the conformance of the map to the terrain, as well as introducing corrections and additions to the map are accomplished from aerial photos from a recent flight and, with the availability of time, also with field investigation (map reconnaissance).

All corrections are plotted on the map by the corresponding conventional signs.

Corrections and additions to the map from aerial photos are performed by the successive comparison of the area (zone) of interest and the transfer of objects from the photos to the map by methods presented in Chapter IV.

Field investigation of the map is accomplished by moving over the area over a previously planned route. All terrain changes along the route and in the immediate proximity of it are applied by the measurement method. For this, the length of the route is measured by speedometer by stages from firmly identified reference points (crossings, intersections, bridges, etc.). Visible objects which are located at a distance of 500 meters or more from the route are plotted along perpendiculars from the line of the route or by direct intersection. In individual cases, it is necessary to move off the main route for a detailed investigation of objects, particularly those in covered places.

The width of the zone of investigation from one route depends on the nature of the terrain. Under conditions of semi-closed terrain, it is approximately 3 km (1.5 km to each side of the route).

8. Visual Survey of a Sector

It is recommended that the survey work be organized in the following order (fig. 91):

inspect the sector, determine its size, and note routes over which it is most expedient to accomplish the inspection (mounted or dismounted) of the sector in surveying;

determine the scale of the survey, mark the initial point on the paper with consideration of the placement of the entire survey sector on the sheet of paper and draw a north-south line;

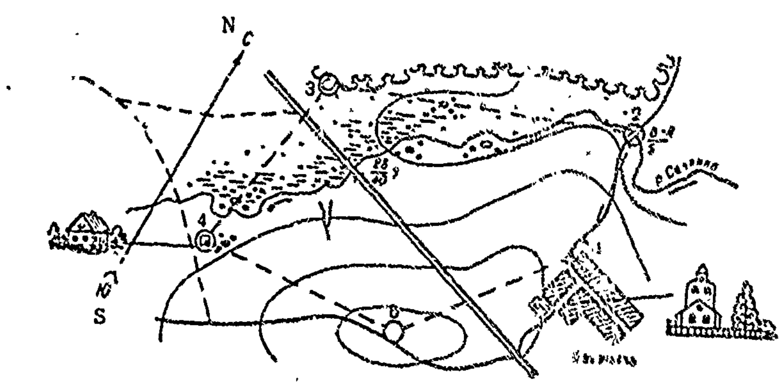
orient the plotting board and draw the first leg (the line of direction along which movement over the route is begun);

maintaining the orientation of the plotting board, draw lines of direction to surrounding local objects, characteristic points (summits, saddles), and elements of the relief (gullies, precipices) which are to be surveyed;

determine the distances to the objects being surveyed and lay them off on the corresponding lines of direction at the scale of the survey;

draw the conventional signs for the local objects and relief elements, the location of which has been determined; intermediate terrain elements are plotted by eye, conforming to the main elements;

draw lines of direction to distant local objects and hills which are to be surveyed by direct intersection; mark down the directions (the notes are made lightly by pencil and can be subsequently erased);



1:10 000

Figure 91. Visual terrain sketch.

move to the second point, measuring the distance and plotting on the drawing objects which are located along the leg of the traverse;

having completed the movement to the second point, determine its location (lay off the distance along the traverse line), orient the plotting board from the first traverse line, and draw a line of direction to the third station, after which the surrounding terrain is surveyed just as at the first point.

The survey is continued in this manner until the traverse is completely closed. The accuracy of the work is considered satisfactory from a practical standpoint if the linear error (distance on the drawing between the location of the first point at the start of the survey and on its completion) does not exceed 1/25 the length of the entire perimeter of the closed traverse.

The final drawing of the relief by contour lines is performed as data is collected and its shape is surveyed from several directions.

The most important reference points can be drawn in their perspective appearance in the form of marginal notes on the margins of the drawing.

The final (clean) finishing of the drawing is performed directly in the field after the traverse has been closed.

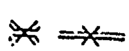
With the availability of a map or aerial photo for the area of survey, a skeleton of the terrain is prepared from them ahead of time - increased to the required scale of the layout of the road, populated places, and other terrain elements. On the basis of this sketch, additional survey is performed, in the field, of the objects which are absent from it, and details are defined more precisely.

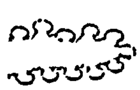
9. Conventional Signs for the Preparation of Terrain Sketches and Plotting Reconnaissance Data on a Map


Blocks with a predominance of fire-resistant structures.

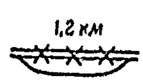

Blocks with predominance of non-fire resistant structures.


Destroyed and partially destroyed blocks.

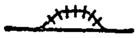

Destroyed objects (crossed out in red).

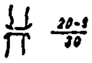

Forest.


Bushes.

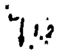


Destroyed (defective) section of road for a distance of 1.2 km and a detour around it.

 Detours which can be made by field expedients.

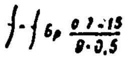
 Bridge characteristics:
$\dfrac{\text{20 - length of bridge, m; 8 - width of roadway, m}}{\text{30 - load capacity of bridge, tons}}$

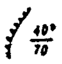
 Bridge requiring repair.

 Depth of swamp, meters.

 Impassable terrain sector.

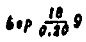
 Terrain sectors which are difficult to negotiate.

 Fords:
$\dfrac{\text{0.7 - depth, m; 15 - length, m}}{\text{B - character of ground (B - viscous, T - solid, K - rocky, - sandy); 0.5 - speed of current, meters per second}}$

 Steepness of slope:
$\dfrac{\text{40° - steepness, degrees}}{\text{70 - length, meters}}$

 Commanding heights, view, km

 Inundated sectors (blue color).

 Data on woods:
species $\dfrac{\text{18 - height, meters}}{\text{0.20 - thickness, m (chest height)}}$ 9 - average distance between trees, meters

 Reference points (circled).

 Mounds, pits, precipices (height and depth, meters).

 Outlines - boundaries of areas.

 Cross-country tracks.

Remarks. Such terrain elements and their characteristics are plotted by conventional symbols of topographic maps. Individual objects or characteristics for which adopted conventional signs do not exist, are plotted arbitrarily but their meaning is explained.

10. Road Reconnaissance

The basic problems of road reconnaissance are:

type (class) of roads, their surface, condition, width of roadway and the entire roadbed;

locations of roadways that are difficult for wheeled and tracked vehicles and the possibility of building detours;

the condition and load capacity of bridges, the presence and dimensions of pipes;

data on overpasses above the roads (underpasses);

possibility of moving off roads;

defiles and routes for bypassing them;

the availability of natural cover against enemy air attack and nuclear bursts close to the roads;

conditions for camouflage and disposition at halts;

sources for water supply;

the availability of local repair materials (sand, gravel, slag, timber materials);

the necessary volume of work and means to repair roads, establish cross-country tracks, fords, and other crossings;

average speed of movement over sectors;

orientation conditions.

The results of the reconnaissance are plotted on a map with conventional signs. Additional characteristics are given in the textual marginal information which is placed on the map or adjacent to it. In the absence of large-scale maps and with the necessity to obtain detailed data on the route, the results of the reconnaissance are formulated while it is being conducted in the form of a sketch with textual and numerical explanations.

11. River Reconnaissance

We determine the following when reconnoitering a river:

the width, depth, and speed of current of the river, nature of the banks, steepness of approaches and exits, soil on the bottom and banks, presence and character of fords, islands, and shoals;

places which are suitable for the crossing of tanks underwater along the river bottom;

approaches to the crossing and places for the covered disposition of crossing means and the troops to be crossed;

the presence of local crossing means and field expedients;

the nature and volume of work necessary to prepare the crossing.

In the course of the reconnaissance, a large-scale sketch (diagram) of the crossing is prepared, or the data are recorded on a large-scale map with the corresponding conventional signs and text in the legend, i.e., a map of a water line is prepared (see p. 30). In the winter, the ice cover on the river is investigated: thickness and structure of the ice (absence of snow, water and air layers), presence and character of areas of open water in the ice, washouts.

12. <u>Reconnaissance of a Bridge</u>

We establish the following when reconnoitering a bridge:

general information on the water obstacle (width, depth, soil on bottom and banks, condition of approach routes, availability and locations of detours);

general information on the bridge (length and width of roadway, size of span, type and height of support), condition of the bridge - places and nature of destruction, places for possible mining, degree of rot and wear;

information on the elements of a wooden bridge (fig. 92) to determine its cargo capacity (material and thickness of crossbeams, thickness of stringers and distance between them, thickness of piles and their height above the ground);

cargo capacity of the bridge (determined from the sign at the bridge, the formula presented below, or from special tables which are given in manuals on engineering);

a method for reinforcing the bridge (if necessary) for the passage of given loads;

the availability of materials for the repair and reinforcing of the bridge (what materials, where and how many are available).

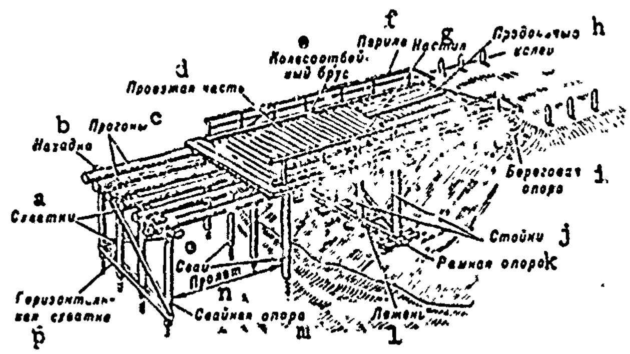


Figure 92. Elements of a wooden girder bridge.

a - interlocks; b - cross stringer; c - stringers; d - roadway; e - curbing; f - handrail; g - flooring; h - longitudinal tracks; i - bank abutment; j - bracing; k - trestle bend; l - sleeper; m - pile bend; n - span; o - [illegible]; p - horizontal interlocks.

Reconnaissance data are drawn up on a separate drawing or recorded on a map with the outline of the longitudinal cross section of the bridge.

<u>The load capacity of basic types of bridges.</u> Ferroconcrete, concrete and stone bridges and metal bridges with through-trusses or with a span structure of riveted girders with a continuous wall, bridges with the main trusses with a span of more than 30 meters, wooden girder and strut bridges located on super highways and improved highways support, as a rule, the passage of tracked vehicles weighing up to 60 tons.

The formula for the approximate determination of the load capacity of wooden girder, strut, and crossbar-strut bridges for tracked vehicles is

$$G = 0.006 \cdot d^3 \cdot n/l - \frac{L}{2},$$

where

G is the load capacity of the bridge, tons (weight of tracked vehicle);

d is the diameter of the stringers, cm;

n is the number of stringers;

l is the length of the bridge span, meters;

L is the length of the bearing surface of the tank track, meters.

In determining the load capacity of bridges, the size of the span of a strut bridge is considered to equal 50% and of a crossbar-strut bridge, 40% of the distance between the supports (fig. 93).

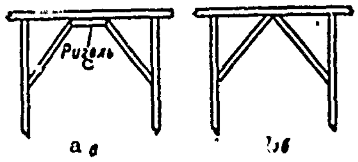


Figure 93. Longitudinal cross section of one bridge span.

a - crossbar-strut; b - strut; c - crossbar.

13. Reconnaissance of a Forest

We determine (elaborate) the following when reconnoitering a forest:

the limits of the forest (edges);

nature of the forest, species, age, vertical layering, height, thickness of trees at chest height, thickness (average distance between trees), weediness of forest, visibility conditions, camouflage properties of the forest, presence of slashings, burnings;

road net;

relief of terrain, particularly gullies, precipices, pits, steep slopes;

rivers, streams, ditches, swampy sectors;

direction of possible movement off roads;

local objects which may serve as reference points.

Reconnaissance data are recorded on a sketch or large-scale map.

To determine the average distance between trees, a sector 10 x 10 meters which is typical for the given forest is selected and the number of trees in it is counted. The average distance between the trees is determined from the formula

$$l = 10/\sqrt{n},$$

where

l is the average distance, meters;

n is the number of trees in an area of 100 square meters.

Visibility conditions are expressed by the average distance of visibility in the forest in meters.

14. Reconnaissance of a Swamp

The following are determined (defined in detail) when reconnoitering a swamp:

the boundaries of the swamp (outline);

depth of the swamp by sectors;

character of the swamp: peat, marshy, swampy land;

number of areas of land which are permanently wet from the outflow of underground water [mochezhina] (percent of the overall area);

nature of the surface: hillocks, ridges, mounds, peat-cutting areas;

plant cover: sectors covered with forest, moss, grass, brush;

presence of rivers, lakes, ditches;

presence of roads, paths;

trafficability of the swamp off the roads, places for passage, necessary measures to improve them;

main reference points.

The trafficability of swamps is determined from their type or directly by measuring the depth to the hard ground with the use of a pole.

Trafficability of a continuous peat swamp can be determined by simple field methods presented in Table 44.

Table 44

Methods for determining the trafficability of continuous peat swamps

Character of swamp	Method of determining swamp trafficability	Allowable pressure, kg/cm^2	Possibility of movement of
Very dense peat, dried or slightly moist	When the peat is compressed in the hand, no reduction in its volume is felt; water is not released.	1.0	Tanks
Peat dense, average moistness	Some reduction in volume is noticed when pressed in hand; water is released but does not flow from the hand; the mass is not pressed through the fingers.	0.75	Tanks
Peat flocculent, wet	A considerable reduction in the volume is noticed when compressed in the hand; water released in drops; peat is pressed through the fingers.	0.50	Tractors

(Table 44 cont.)

Peat very floccu-lent, very wet	When peat is compressed in the hand, water flows out in a small stream; the mass is pressed through the fingers.	0.25	Pedestrians
Peat running, liquid	Mass completely pressed through . fingers.	0.12-9.14	Impassable

Data of swamp reconnaissance are recorded on a large-scale topographic map or on a specially prepared diagram.

15. Reconnaissance of Soils and Ground

The reconnaissance of soils and ground is conducted from the point of view of their trafficability, difficulty in working, radioactive contamination (induced radiation), and dust formation.

In reconnaissance, we determine:

soils (tundra, podsolized, black soils, chestnut soils, grey desert soils, salt marshes, dark strongly alkaline soils [solonets]);

soil quality for difficulty in working - light, heavy, rocky, crag, quicksand (the quality of cohesive soils in accordance with their density, Table 45);

the nature of the ground in accordance with the content of clay particles - sandy, sandy loam, lomay, clayey (Table 46).

Table 45

Field determination of density of cohesive soils

Category of soils	Method of determining density of soils
Loose	Shovel enters the ground feely. When ejected, chunks of dirt fall apart into small particles
Packed	Shovel is buried in the ground to the depth of the spade when pushed with the foot. Chunks which are removed fall apart into individual elements of different sizes
Dense	Shovel enters the ground with difficulty and is not buried immediately to the depth of the spade. Chunks of dirt are broken up by the hands with difficulty
Very dense	Shovel does not go into the ground. Chunks are not broken up by the hands

Table 46

Determination of loose soils under field conditions

(by the content of clay particles)

Soil	Soil condition		Method of determination in moist state	
	In dry state	In a wet state	By pressing	By rolling
Clayey	Very hard, in chunks	Viscous, plastic, very soft	A ball pressed into a cake does not crack along the edges	On rolling, a long, thin string 0.5 mm in diameter is formed
Loamy	Less hard, when struck by a hammer clods and chunks crumble into fine particles	Plastic, viscosity weak	A ball pressed into a cake cracks along the edges	A string is obtained which is thicker and shorter than when rolling clayey soil
Sandy loam	Clods easily crumble and break up from a blow	Not plastic	Ball crumbles in pressing	String can hardly be rolled
Sandy	No tenacity	Not plastic and not tacky	Ball cannot be made	String is not rolled

Chapter X

Preparing a Terrain Mock-Up

1. General Information, Organization of the Work

A terrain mock-up is prepared directly on the ground or in a special box in a room.

The terrain area which is selected for the preparation of the mock-up should provide camouflage, as well as convenience for the disposition of the personnel on it during the work (the gaming of the missions). It is extremely desirable that the area of the mock-up be raised somewhat in the direction of the enemy. The orientation of the mock-up relative to the points of the compass (particularly when it is set up on the ground) should correspond to the actual orientation.

The best locally available material for depicting the relief may be considered to be a mixture of sand and clay. In the winter, the relief of the mock-up which is set up on the ground is made from snow.

The surface of a mock-up which is not occupied with local objects may be left without additional cover, i.e., dirt (snow), or it may be covered with a packed layer of sawdust colored in various colors, or it may be covered with a cement solution with subsequent coloring with oil or enamel paints.

The scale of the mock-up depends on its purpose (for a battalion, for a regiment, etc.). For working out offensive actions by chast' and podrazdeleniye, a typical scale of the mockup is 1:5000 to 1:10,000, and for soyedineniye and ob"yedineniye, 1:25,000 to 1:50,000 or smaller. In working out defensive missions, the scale of the mock-up is usually larger.

The relation between the horizontal and vertical scales is:

for flat terrain - from 1:25 6o 1:10;

for hilly terrain - from 1:10 to 1:5;

for mountain terrain - from 1:5 to 1:2.

Example. The horizontal scale of the mock-up is 1:10,000. The terrain is hilly.

The vertical scale for reflecting the relief on the mock-up may be taken from 1:1000 to 1:2000.

The work group for preparing the mock-up is: one officer, one sergeant, and three or four soldiers. The productivity of a group per day with the availability of materials on the spot is 10-15 square meters of mock-up without surfacing, and 5-8 square meters when finishing the surface with sawdust or other materials.

For the purpose of speeding up the work, the mock-up may be divided into sectors for several workers, in which respect the size of each sector should be at least four square meters.

2. Materials and Tools

For making a terrain mock-up, the materials indicated in Table 47 are needed.

Table 47

Typical calculation of material requirement for 100 m^2 of mock-up

Name of material	Unit of measurement	Without finishing the mock-up surface	With finishing the surface	
			with sawdust	with cement
Dirt (mixture of sand and clay)	m^3	20	20	20
Boards, 30-40 mm thick for sides (may be replaced by poles or sod)	m^3	0.5	0.5	0.5
Plywood, 3 mm thick	sheets	1	1	1
White wood sawdust	m^3	0.1	0.5	0.1
Cement	kg	3	3	200
Paper hanger's glue (carpenter's glue)	kg	2(1)	100(50)	2(1)
Oil or enamel paint	kg	2	2	15
Dry adhesive paint	kg	1.5	20	1.5
String	meter	80	80	-
Tape	meter	120	120	-
Binder twine	kg	0.5	0.5	0.5
Thin wire	kg	0.5	0.5	0.3
Small nails	kg	0.2	0.2	0.2
Nails, 100-mm	kg	5	5	5
Draftsman's paper	sheets	2	2	2
Liquid chemical India ink:				
Black	small bottle	1	1	1
Red	"	1	1	1
Blue	"	1	1	1
Brown	"	1	1	1
Yellow	"	1	1	1

The tools and accessories which are necessary to make the mock-up are: shovels, axes, cross-cut saw, hacksaw, tape measure, wooden laths 40-50 cm long with centimeter divisions; wooden shovels with a thickness of cut of from 4 to 7 cm, 0.5 meters long, small tubes, and poster pens.

3. Making the Mock-Up

a) Work procedure

It is expedient to perform the preparatory work in the following order:

prepare a map of the largest scale and with recent content: where necessary, correct it from aerial photos;

outline the area on the map and study it carefully;

determine the vertical scale (horizontal scale is determined ahead of time with consideration of the task);

mark down the numbers of the kilometer lines or the lines of a specially applied grid on the map along the margin of the sector (it is recommended that this be done in the case where the directions of the zones do not coincide with the direction of the lines of the map kilometer grid);

highlight the relief and local objects which are to be transferred to the mock-up (in accordance with the task and scale of the map);

count the number of local objects on the map and select the necessary materials (moss, branches, models of houses, means for designation, etc.);

select and plan the area. Remove the grass cover, loosen the soil thoroughly to a depth of 20-25 cm, clear the clumps from it and smooth it out with the use of the dirt as a material for depicting the relief, or bring in and work in accordingly the necessary amount of dirt;

prepare and set up the frame of the mock-up (line it with boards, sod, poles);

note the places where the grid lines come out, drive in stakes, mark them, and stretch the grid at a height of 15 to 20 cm from the surface of the ground.

To prepare the relief, it is necessary:

from the grid, to plane the commanding heights, main ridges, and drive in stakes of the corresponding height (to scale), taking the surface of the sand (snow) as the average height of the terrain relief;

by marking out (with a shovel, marker, nail) to note the rivers, streams, draws, and ravines; deepen them in which case the dirt which is taken away is used to finish off the hills and ridges to the level of the stakes which were knocked in earlier;

successively (by squares) to refine the relief, and to plan and portray the important relief details (gullies, precipices, pits), in individual cases allowing their exaggeration to make them more prominent;

to secure the relief by wetting, tamping, and smoothing (with a shovel or with hands).

b) Designating local objects

Local objects are placed (designated) in the following sequence: populated places, reference points, plant cover, rivers, lakes, road net.

Local objects are designated as follows:

populated places - by models of houses of various sizes and coloring which correspond to actual conditions; the number of houses which are set out should only reflect the comparative dimensions of the populated places, and the disposition of the models should reflect their layout;

reference points - by corresponding models of wood, clay, or plaster of Paris;

forests - branches of small-leafed plants, juniper, spruce; moss; sawdust painted green; painted oakum or cotton (in the form of trees and bushes);

swamps - with sawdust painted green and sprinkled from above with crushed glass, brilliant green, or fine green moss;

lakes and rivers - by glass painted blue on the bottom; painted sawdust; painted cord;

vehicle and horse-drawn transport roads - by sprinkling painted sawdust or finely ground brick; by painted tape, cord, binder twine (the color is selected in accordance with the color of the conventional sign);

railroads - tape with intervals painted black; by sprinkling with sand (brick, sawdust) with the laying of matches in the form of crossties and the stretching of thin wire or threads to portray the rails;

telephone and power lines - with matches which portray the poles and wire or thread to simulate the conductor;

bridges - sheets of small boards or plywood.

c) Designing the mock-up

The north-south direction is designated by a wooden arrow, 1 to 2 m long.

The names of the populated places, rivers, lakes, and terrain features are made on paper with black India ink at a size which assures their good readability. The paper is glued to plywood; signs (on stakes) are placed at the corresponding objects facing a certain direction (to the rear).

In finishing up the mock-up with sawdust, in a 0.75 bucket of hot water we dissolve 0.5 to 0.7 kg of joiner's glue or 1 to 1.5 kg of paper hanger's glue, pour in 150 to 200 grams of the corresponding paint, mix them together, and fill the bucket with the addition of sifted sawdust. The painted sawdust is applied to the mock-up in a layer and is packed down by the shovels.

In finishing the mock-up with cement, we pour into a bucket one part cement and 5-6 parts (by weight) clean, sifted sand; mixing them together, we add water until a paste-like mass is formed. We pour the solution uniformly over the surface of the mock-up, carefully smoothing it out with shovels or by hand, and wetting it with water.

We can begin painting the mock-up after 1.5 to 2 hours. Enamel paints dry out in 1 to 2 hours and oil paints in 12 to 24 hours. Dry adhesive paints may also be used. For this, 200 to 300 grams of paint and 1 kg of joiner's glue or 2 kg of paper hanger's glue are diluted in a bucket with hot water. Turpentine or a desiccant are added if a rapid drying of the oil paints is desired.

4. Plotting the Tactical Situation on the Mock-Up

The tactical situation is plotted on the mock-up in the same sequence as when working with a map. On the mock-up, we designate:

boundary lines - by tape, cord, cable, or binder twine, painted red;

FEBA - tape or by corresponding signs cut out from plywood (cardboard): friendly troops, red; enemy, blue;

the situation and missions of the podrazdeleniye, chast', and soyedineniye - by the corresponding conventional signs;

rockets, artillery, mortars, tanks, self-propelled artillery units, and machine guns at firing positions and on the march - by the corresponding conventional signs of plywood or by models;

hasty field roads - by tape or by sprinkling sawdust (sand) which can be distinguished from the road net by its color;

command posts - by the corresponding conventional flags on stakes;

observation posts - by conventional signs cut out of plywood or cardboard.

Chapter XI

Methodological Advice on Organizing and Conducting Lessons in Military Topography

1. Preparation and Organization of Lessons in Military Topography

The content of military-topographic training, just as of all other types of combat training, is determined by the corresponding programs. However, in a number of cases, even with personnel having good topographic training, it is necessary to conduct lessons in individual subjects or problems. Such a necessity usually arises:

a) with the redisposition to an area which is characterized by a new type of terrain;

b) in preparing to accomplish combat missions under specific terrain conditions which have a significant influence on the methods and means for its study and orientation on it;

c) on receiving new maps and aerial photo documents for support and improved means of orientation (navigation apparatus, etc.).

The main sections of military topography in which subordinates are trained to one degree or another by officers of all combat arms are:

a) the terrain, its elements, and tactical properties;

b) topographic maps and their use for studying the terrain, organization of the battle, and control of troops in combat;

c) aerial photos and their use for the detailed study of the terrain and reconnaissance of the enemy;

d) orientation on the terrain;

e) the preparation of diagrams and other graphical documents concerning the terrain.

The director of the lesson, in beginning to organize lessons in accordance with a certain program, should:

determine the training goal of each lesson taking the interrelationship between them into consideration;

plan the area for the lessons which assures the conditions for working out the training problems;

determine the necessary material and technical support for the lessons (maps and aerial photos, compasses, rulers, dividers and other tools, visual aids and training literature, transportation and navigation means).

The basic method for lessons on military topography is the practical lesson on the ground. However, this does not exclude the necessity for a lecture presentation of theoretical materials and practical knowledge in the classroom. Questions on the essence of portraying relief by contour lines,

the coordinate system, stereoscopic interpretation of aerial photos, and others, may be studied most successfully with the use of texts and tools in offices equipped in the corresponding manner, or in classrooms.

To develop several practical skills (movement by azimuth, orientation in movement with the use of navigational equipment, and others), the best trained officers and sergeants, commanders, and vehicle drivers who directly support the lesson, as well as other necessary personnel, are used to assist the one who is conducting the lesson.

All practical assignments should be performed by each trainee. In actions by groups, the roles of trainees as part of the group are changed successively and the actions of each of them are graded for each element and for the assignment as a whole.

Preparation for the lesson includes:

clarification of the overall content and goal of the lesson;

study of the literature, basic literature which is recommended for study by the trainee and additional literature;

determination of training problems and the sequence, procedures, and time for working them out;

reconnaissance of the lesson area;

preparation of a lesson plan.

The area for the lesson is selected in such a way that it contains the necessary topographic and tactical elements for the course of the lesson; where necessary, a target situation is set out ahead of time. The nature of the terrain should become more difficult from lesson to lesson and the area should be changed where possible.

As a rule, the movement out to the lesson area should be included in the lesson plan (for drilling in orientation, comparing the map with the terrain, and disclosing the changes which have taken place on it, etc.).

Let us consider a lesson plan using a specific example.

2. Typical Lesson Plan for a Subject: "Orientation on the Ground from a Map (at the Halt)"

Training goal. To teach procedures in orienting the map, finding own station and visible objects on the map, as well as finding on the ground the location of objects which are designated on the map.

Time - 4 hours.

Method. Practical lesson on the ground.

Material support. Maps of the lesson area at a scale of 1:50,000, compasses, plotting boards, sight rules, protractors, pencils, sheets of transparent paper, 20 x 20 cm - for each trainee, vehicles - for riding out to the lesson area.

Literature. Indicated in the basic training texts.

Content and Procedure for Conducting the Lesson

(fig. 94)

Place and time	Content and work procedures
Moving out to lesson area - 20 minutes	Prior to moving out: 1) checking material support; 2) assigning missions for the attentive study and memorizing of the terrain along the route of movement.
Work point No. 1 - 20 minutes	1) Listening to the reports of 2-3 trainees concerning the terrain along the route of movement. 2) Announcing the subjects and training goal of the lesson. 3) Orienting the map in accordance with the direction of the road and finding own location by the successive identification of surrounding local objects and relief forms. 4) Assigning the mission to count the pairs of paces to determine point No. 2 which is located in a forest.
Work point No. 2 - 15 minutes	1) Determining own location by measurement from work point No. 1. 2) Elaborating on the map the location of clearings in the forest (by measurement, from the relief).
Work point No. 3 - 15 minutes	1) Determining own location by the method of a perpendicular from a trigonometric point toward the road. 2) Plotting bushes which have not been designated on the map by the measurement method.
Work point No. 4 - 25 minutes	1) Orientation of the map by compass. 2) Determining own location by resection (from a trigonometric point, windmill, and lone tree), graphically and from measured azimuths (for a check).
Work point No. 5 - 20 minutes	1) Determining own location from a line of direction (plant-lone tree) and the road. 2) Plotting pits on a map from direction and distance 3) Determining the location of a fuel dump on a map (by direct intersection, 1st line of direction).
Work point No. 6 - 15 minutes	1) Orientation of a map from local objects (lone tree, plant). 2) Direct intersection of a fuel dump (2d line of direction).
Work point No. 7 - 20 minutes	1) Determining own location using transparent paper (from the plant, road marker, and windmill). 2) Detailed comparison of the map with the terrain and making the corresponding additions and corrections.
Work point No. 8 - 30 minutes	1) Independent determination of own location; method - by the choice of the participants. 2) Check (by direct sighting) of the correctness of determination of the location of a dam which is being built.

(cont.)

Place and time	Content and work procedures
	3) Checking the correctness of the determination of own location by each trainee (with the use of tracing paper - copying from the map - from a previously determined station). 4) Critique of the lesson and assignment for independent study (call attention to the selection of the most rational method of action in each specific case in orienting and to the accuracy of graphical construction).

Remarks: 1. The time indicated in the plan includes work at a station and movement to the next one.

2. The working out of each new method of action begins with a brief explanation and sample demonstration.

For convenience in use, the lesson plan may be prepared completely on a diagram, the scale of which should be sufficiently large and should permit placing the corresponding notations on it. The content, work procedures, and allotted time in this are indicated directly at the work point. In preparing a text lesson plan, the route, work points, objects for reconnaissance and intersection, etc., may be designated on the map; in this case, there is no practical requirement to prepare a special diagram.

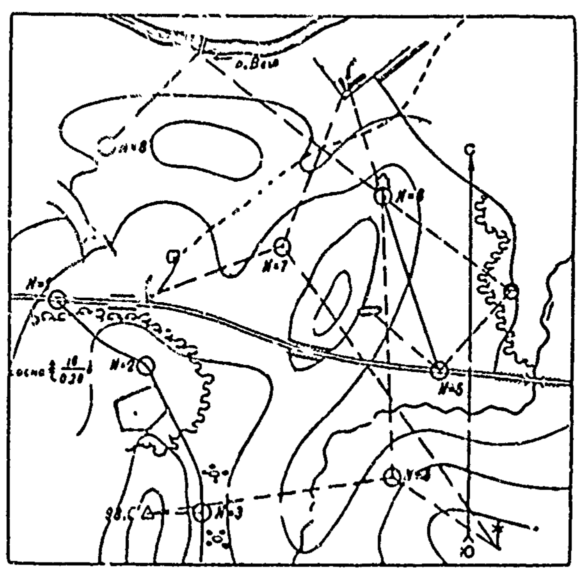


Figure 94. Diagram to accompany a lesson plan on the subject: "Orientation on the ground by map (at the halt)."

With insufficient experience in conducting lessons, to supplement the lesson plan one should prepare a detailed lesson plan in which the training problem should be presented successively, required definitions should be given, procedures for actions should be shown, and examples, check questions, and questions to reinforce the material as well as auxiliary data, which may be required on the lesson, are selected.

Brief recommendations for the subject "orientation with the use of navigational apparatus of ground vehicles" are presented below because this subject is comparatively difficult and, for the time being, methodological materials on it are very few in the military-topographic training literature.

3. Brief Methodological Recommendations for the Subject: "Orientation with the Use of Navigational Apparatus of Ground Vehicles."

The subject "Orientation with the use of navigational apparatus of ground vehicles" is worked out on the ground with materiel (5-6 hours) and in the classroom (1-2 hours). The main training problems are:

1) the order for orientation during movement of a vehicle which is equipped with navigational apparatus without a plotter and with a course plotter;

2) beginning (initial) orientation of the vehicle;

3) work with the navigational apparatus en route and replacement of the map;

4) special features of orientation at a junction of zones.

The working out of this subject should be preceded by a lesson on the study of the materiel of the navigational apparatus and the order for its operation, as a result of which the trainees should assimilate the tactical and technical data on the apparatus and learn to turn the apparatus on and off. The materiel, as a rule, should be studied under the direction of a specialist for the electrical equipment of the vehicles in a classroom equipped with operating models of the navigational apparatus.

Prior to the start of the lesson, a reconnaissance of the lesson area is conducted, two routes suitable for the movement of vehicles are planned, and initial points and reference points required for the initial orientation of the vehicles are selected.

On the first route, it is desirable to have approximately in the middle a terrain point and straight line sector of the route, which are necessary for checking and correcting the operation of the apparatus.

Where possible, the second route is planned across the junction of map sheets at a scale of 1:25,000 (or 1:50,000). If there is no map junction in the lesson area, the route is selected in such a way that the map may be cut in approximately two parts for working out the process of replacing the map on the plotting board of the course plotter.

In addition, the route is noted on a 1:100,000 map before the start of the lesson (movement will not be accomplished over this route but data will be prepared for orientation en route). On this route there should be 2-3 terrain points, a section of a straight-line road, and a cross-country trail.

The vehicle drivers who are taken out on the lesson should be able to turn the navigational apparatus on and off, insert the initial data, and install the map. The drivers check the actions of the trainees with the apparatus and render them necessary assistance.

The first training problem - the order for orientation in movement on a vehicle equipped with a navigational apparatus - is worked out in the classroom. The order for orientation and preparation of necessary data is presented and then the route is announced: the trainees prepare a 1:100,000 map and data for orientation on the vehicle equipped with a navigational system of a given type.

The second training problem - initial orientation of the vehicle - is worked out directly at the initial point of the first route at which the vehicle (vehicles) are placed. Using a poster and direct demonstration on the ground, the essence and order for initial orientation of the vehicle are explained; the trainees determine the position of their location on the map and find the reference points (at least two) and then they determine the initial data (initial grid azimuth of the longitudinal axis of the vehicle is determined twice, from two reference points).

The third training problem - work with the navigational apparatus en route and replacing the map - is worked out directly on the vehicle. At the initial point (or ahead of time) the crews are determined for the vehicles (3-6 men per vehicle) and for shifts (it is inexpedient to have more than two shifts) and the commanders of the vehicles (shifts) are designated.

The turning on of the apparatus and the input of the initial data are performed under observation of the driver. The chief of the vehicle reports readiness to begin movement; having received permission, he gives the corresponding commands to the driver. During movement, the trainees follow the operation of the equipment and, at the corresponding points and straight-line sectors of the route, they check the generation of the coordinates and course. Upon completion of movement over the first route (this route should be closed), they read the coordinates from the scale, the drift of the gyroscope is determined, and the apparatus is turned off (the gyroscope is not braked). The chief of the vehicle reports the completion of movement and he shows the map and data read from the scales. The instructor grades the actions of the trainee, as well as the work of the apparatus and, where necessary, gives instructions to correct shortcomings in the work.

The shifts of the trainees who are not occupied on the vehicles drill in the initial orientation of the vehicle. For this, the instructor indicates a new initial point and reference point to them on the map and he gives an angle: longitudinal axis of the vehicle-reference point. The trainees determine the initial data and show the position of the vehicle (its longitudinal axis) and the necessary angles on the map.

The changing of the map on the plotting board of the course plotter is worked out on the second route. The instructor explains ahead of time the order of actions in replacing the map and then this question is worked out directly in movement on the vehicle.

The fourth training problem - special features in orienting at a junction of zones - is worked out by explaining the essence and order for replacing maps at the junction of zones, as well as practically by the actions of the trainees with apparatus without a plotter.

Chapter XII

General Reference Data

1. Determining the Duration of Daylight

Duration of daylight - the time interval from dawn until the onset of darkness - depends on the geographic latitude of the location and the data, as well as on the character of the terrain and meteorological conditions (in a forest, in canyons, with a dense cloud cover, and under certain other conditions the duration of daylight is somewhat shorter).

The approximate time of the onset of sunrise and darkness can be determined from a special chart (fig. 95), knowing the latitude of the location (it is determined from a geographic or topographic map with an accuracy of 1°) and the date. For this, in the upper part of the chart we find the point of intersection of the vertical line which corresponds to the date (markings are given on the chart top and bottom) and the curve which corresponds to the latitude of the location (latitude markings are given on the curves); on the right or left of the chart (along the horizontal line which is drawn from the obtained point) the time of sunrise is read. If the latitude of the point, date or time, do not coincide with the numbering, interpolation is performed, i.e., we find the corresponding value in the interval.

The time for the onset of darkness is determined by a similar procedure in the lower part of the chart.

On the chart, the dotted line shows the line for reading the time of sunrise (0320 hours) and the onset of darkness (2250 hours) for a point with a latitude of 56° on 15 July.

Remarks. The time determined from the chart is statute time (see p. 11).

2. Measures of Length and Area

a) Measures of length

Arshin - 0.7112 meters

Versta = 500 sazhenes = 1.0668 km

Vershok = 4.4449 cm

Gaz (india) 0.69 meters

Gotszar (Mongolian People's Republic) = 0.58 km

Dyuym (inch) 2.54 cm

Kabel'tov - 0.1 sea miles = 185.2 meters

Kassaba (United Arab Republic) - 3.55 meters

Kilometer 1000 meters 0.9374 verstas

Koss (India) 1.83 km

Li (China) 0.50 km

Li (Korea) 3.94 km

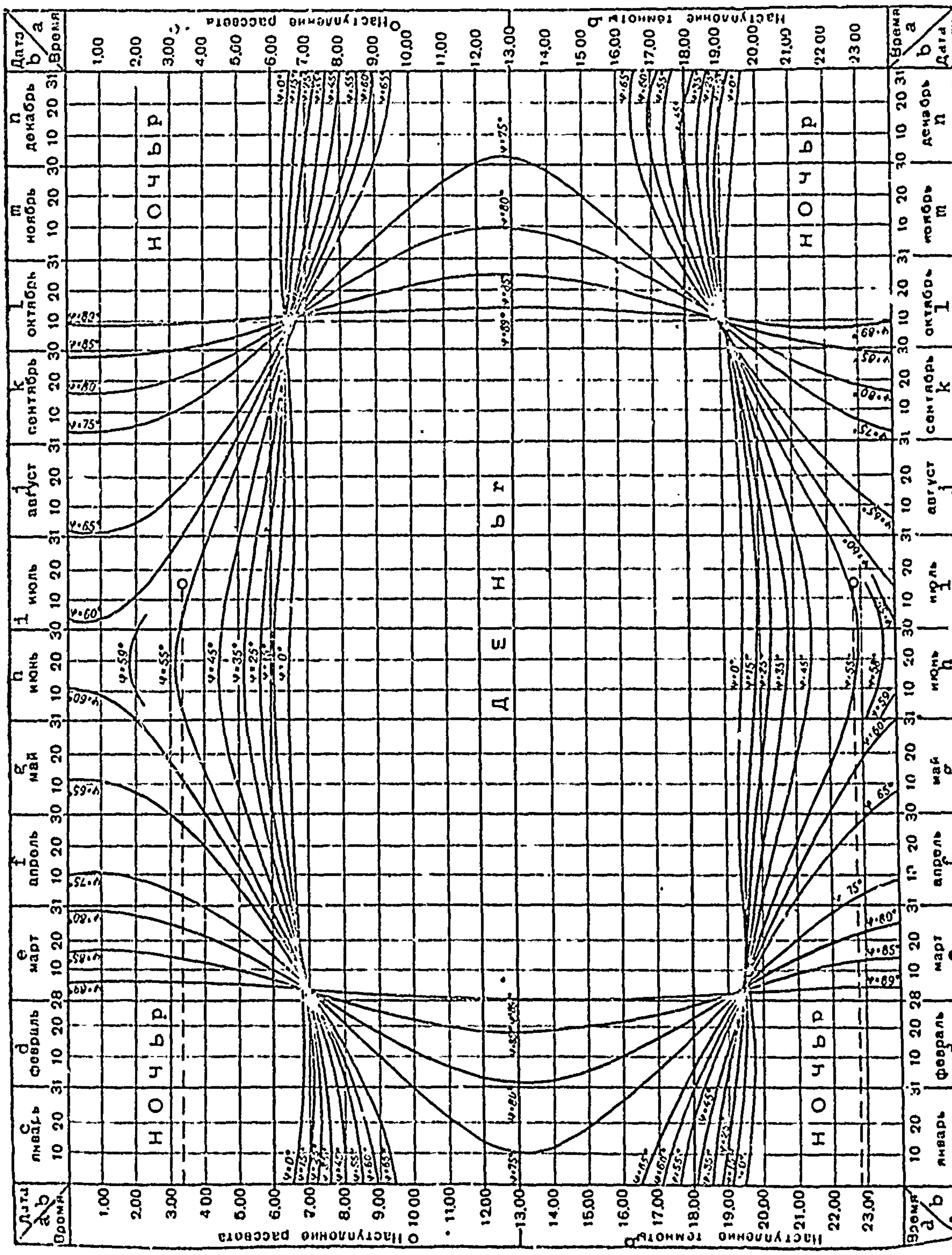


Figure 95. Chart for determining time of onset of darkness and sunrise.

a - time; b - date; c - January; d - February; e - March; f - April; g - May; H - June; i - July; j - August; k - September; l - October; m - November; n - December; o - onset of sunrise; p - night; q - onset of darkness; r - day.

Liniya (line) = 0.1 inches = 10 points = 2.54 mm

Lokot' (Bulgaria) = 65 cm

Lieue (L'ye) (French) = 4.44 km

Mertfol'd, marfol'd (Hungary) = 8.35 km

Meter = 100 cm = 1000 mm = 3.2809 feet = 1.4061 arshins

Millimeter = 0.001 meter = 0.0349 inch

Milya (Rumania) = 7.85 km

Milya (mile) geographic = 4 minutes of latitude = 7412.60 meters

Milya (mile) naval (United States, Great Britain, Canada) = 1 minute of latitude = 10 kabel'tov = 1852.0 meters

Milya postal = 8.35 km (Poland) and 7.59 km (Czechoslovakia)

Mile statute (United States, Great Britain, Canada) = 1.609 km

Point = 0.376 mm

Ri (Japan) = 3.93 km

Sazhen' = 3 arshins 48 vershoks = 7 feet = 84 inches = 2.1336 meters

Centimeter = 10 mm = 0.3937 inches = 0.225 vershoks

Point (tochka) = 0.01 inch = 0.2540 mm

Tuaz (France) = 1.95 meters

Faden (Germany) = 1.83 meters

Farzakh (United Arab Republic) = 1.74 km

Foot = 12 inches = 30.480 cm

Khvat (Yugoslavia) = 1.90 meters

Chetvert' = 4 vershoks = 17.78 cm

Chzhan (China) = 10 chi = 100 tsuney = 3.2 meters

Chi (China) = 32 cm

Shag (Czechoslovakia) = 1.90 km

Yard = 3 feet = 0.9144 meters

b) Area measures

Acre (United States, Great Britain) = 0.4047 hectares = 4047 square meters

Ar = 0.01 hectares = 100 square meters

Bakhoe (Indonesia) = 0.71 hectares

Bigkha (India) = 0.13 hectares

Vluka (Poland) = 16.8 hectares

Hectare = 100 ars = 10,000 square meters = 0.9153 desyatines

Gubnyar (Mongolian People's Republic) = 100 ure = 9.22 hectares

Desyatina = 1.0925 hectares

Dzherib (Iran) = 0.11 hectares

Dyulyum (Bulgaria) = 1 uvrat = 0.09 hectare

Kauni (India) = 0.54 hectare

Quadrat (Germany) = 14.18 square meters

Lan (Czechoslovakia) = 17.26 hectares

Lanats (Yugoslavia) = 0.72 hectare

Morg (Poland) = 0.5598 hectare

Morgen (Germany) = 0.26 hectare

Mu (China) = 0.06667 hectare = 666.7 square meters

Te (Japan) = 0.99 hectare

Falcha (Rumania) = 1.43 hectares

Feddan (United Arab Republic) = 0.42 hectare

Khol'd kadastrovyy (Hungary) = 0.58 hectare

Khol'd malyy (Hungary) = 0.43 hectare

Tsin' (China) = 16 lyan = 596.8 hectares

Tsin (China) = 100 mu = 6.67 hectares

Chen (Korea) = 10 tan = 0.99 hectare

3. Wind Velocity and Force

The wind velocity and force are determined from the indicators presented in Table 48.

Table 48. Table for determining wind force and velocity

Wind force, points	Type of wind	Wind velocity, met/sec / km/hr	Wave height in ocean, meters	Effect of wind on surface of sea	Wind pressure,* kg/m^2	Effect of wind on ground objects
0	Calm	$\frac{0.0-0.5}{0}$	0	Mirror-like sea	0	Smoke rises vertically, leaves on trees don't move
1	Quiet	$\frac{0.6-1.7}{4}$	Less than 0.3	Ripples	0.1	Smoke rises inclined, leaves on trees rustle. Face senses a slight blowing
2	Light	$\frac{1.8-3.3}{9}$	Less than 0.3	Small wave crests appear	0.5	The same
3	Weak	$\frac{3.4-5.2}{16}$	Less than 0.3	Small waves begin to tip; foam glassy	2	Flags and small branches of trees with leaves flutter. Surface of standing water ripples.
4	Moderate	$\frac{5.3-7.4}{23}$	0.3-1.0	Waves become well noticed; in places foaming "crests" are formed. Breakers accompanied by short noise	4	Pennants spread, branches of trees even without leaves flutter; scraps of paper and dust are raised from the ground.
5	Fresh	$\frac{7.5-9.8}{31}$	1.0-1.7	Entire sea covered with "crests", noise of breakers becomes stronger and is perceived as steady roar	6	Large flags spread, big trees begin to shake, small waves are formed on surface of standing water. Whistles in the ears.
6	Powerful	$\frac{9.9-12.4}{40}$	1.7-2.5	Crests of large waves and foaming crests begin to form which occupy large surface. Breakers accompanied by hollow peals.	11	Large bare brushwood shakes, whistles when meeting on its path structures and other stationary objects. Humming of telegraph wires heard.

(Table 48 cont.)

Wind force, points	Type of wind	Wind velocity, met/sec / km/hr	Wave height in ocean, meters	Effect of wind on surface of sea	Wind pressure, kg/m^2	Effect of wind on ground objects
7	Strong	12.5-15.2 / 50	2.5-3.5	Waves tower and destruction occurs. Wind cuts white foam from crests and spreads it in strips with the wind. Noise of breakers heard in distance.	17	Trunks of trees even without leaves shake. Numerous "breaking crests" on wave crests in standing water. Walking against the wind is difficult.
8	Very strong	15.3-18.2 / 60	3.5-6.0	Height and length of waves increase considerably; foam lays with wind in thicker strips. Noise on open sea acquires character of peals.	25	Large trees shake, branches and brushwood break. Any movement against the wind is delayed noticeably.
9	Storm	18.3-21.5 / 72	6.0-12.0	High, mountain-like waves with long tipping crests; foam covers slopes of waves almost continuously to base.	35	Large bare brushwood of trees is broken, light objects are moved, roofs damaged.
10	Heavy storm	21.6-25.1 / 84	6.0-12.0	Entire surface of sea becomes white with foam; air filled with water spray and droplets. Noise on open sea acquires character of blows.	46	Trees uprooted and considerable destruction occurs.
11	Fierce storm	25.2-29.0 / 97	Above 12.0	Height of waves is so great that ships in the field of view are hidden behind them at times. Sea is coverd by white strips of foam elongated with the wind. Peals on open sea converted to continuous roar.	64	Great destruction occurs.
12	Hurricane	More than 29.0 / More than 104		Water spray torn from crests becomes so dense that visibility is reduced considerably.	Above 74	Devastation occurs.

4. Conversion of Mils to Degrees, and Vice Versa

The procedure for converting large and small mil values to degrees and vice versa is indicated in Tables 49 and 50.

Table 49

Table for converting large mil values to degrees

Десятки больших делений угломера a	Единицы больших делений угломера b										Десятки больших делений угломера d
	0	1	2	3	4	5	6	7	8	9	
	Градусы c										
0	0	6	12	18	24	$\boxed{30}$	36	42	48	54	0
1	60	66	72	78	84	90	96	$\boxed{102}$	108	114	1
2	120	126	132	138	144	150	156	162	168	174	2
3	180	186	192	198	204	210	216	222	228	234	3
4	210	246	252	258	264	270	276	282	288	294	4
5	300	306	312	318	324	330	336	342	348	354	5
6	360										6

Key: a - tens of large mil values; b - units of large mil values; c - degrees; d - same as a.

Table 50

Table for converting small mil values to degrees

Десятки малых делений угломера	Единицы малых делений угломера b										Десятки малых делений угломера
a	0	1	2	3	4	5	6	7	8	9	a
0	0°00',0	0°03',6	0°07',2	0°10',8	0°14',4	0°18',0	0°21',6	0°25',2	0°28',8	0°32',4	0
1	0 36,0	0 39,6	0 43,2	0 46,8	0 50,4	0 54,0	0 57,6	1 01,2	1 04,8	1 08,4	1
2	1 12,0	1 15,6	1 19,2	1 22,8	1 26,4	1 30,0	1 33,6	1 37,2	1 40,8	1 44,4	2
3	1 48,0	1 51,6	1 55,2	1 58,8	2 02,4	2 06,0	2 09,6	2 13,2	2 16,8	2 20,4	3
4	2 24,0	2 27,6	2 31,2	2 31,8	2 38,4	2 42,0	2 45,6	2 49,2	2 52,8	2 56,4	4
5	3 00,0	3 03,6	3 07,2	3 10,8	3 14,4	3 18,0	3 21,6	3 25,2	3 28,8	3 32,4	5
6	3 36,0	3 39,6	3 43,2	3 46,8	3 50,4	3 51,0	3 57,6	4 01,2	4 04,8	4 08,4	6
7	4 12,0	4 15,6	4 19,2	4 22,8	4 26,4	4 30,0	4 33,6	4 37,2	4 40,8	4 41,4	7
8	4 48,0	4 51,6	4 55,2	4 58,8	5 02,4	5 06,0	5 09,6	5 13,2	5 16,8	5 20,4	8
9	5 24,0	5 27,6	5 31,2	5 34,8	5 38,4	5 42,0	5 45,6	5 49,2	5 52,8	5 56,4	9
10	6 00,0										10

Key: tens of small mil values; b - units of small mil values.

Example 1. Convert an angle of 1729 mils to degrees. From Table 49, we find the value of 17 large mil values (102°) and from Table 50, the value of 29 small mil values (1°44.4'); we add them and obtain the result: 102° + 1°44.4' = 103°44.4'.

Example 2. Convert an angle of 32°18.3' to mils. In Table 49, we find the corresponding or closest smaller value of the angle in degrees and the angle which corresponds to it in mils. In our example, this will be 30° which corresponds to 500 mils. The remainder of the angle (in our example it equals 32°18.3'- 30° = 2°18.3') is found in Table 50; for 2°16.8' (we do not consider the angular value of 1.5') it equals 38 mils. Thus, the size of the entire angle equals the sum of 500 + 38 = 538.

5. Trigonometric Values

Natural values of sines, cosines, tangents, and cotangents are presented in Table 51.

Table 51

Table of natural values of trigonometric values

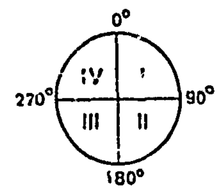
Градусы Degrees	sin	cos	tg tan	ctg cotan	Градусы Degrees
0	0,0000	1,0000	0,0000	∞	90
1	0,0175	0,9998	0,0175	57,2899	89
2	0,0349	0,9994	0,0349	28,6362	88
3	0,0523	0,9986	0,0524	19,0811	87
4	0,0698	0,9976	0,0699	14,3007	86
5	0,0872	0,9962	0,0875	11,4300	85
6	0,1045	0,9945	0,1051	9,5143	84
7	0,1219	0,9925	0,1228	8,1443	83
8	0,1392	0,9903	0,1405	7,1154	82
9	0,1564	0,9877	0,1584	6,3137	81
10	0,1736	0,9848	0,1763	5,6713	80
11	0,1908	0,9816	0,1944	5,1445	79
12	0,2079	0,9781	0,2126	4,7046	78
13	0,2250	0,9744	0,2309	4,3315	77
14	0,2419	0,9703	0,2193	4,0108	76
15	0,2588	0,9659	0,2679	3,7320	75
16	0,2756	0,9613	0,2867	3,4874	74
17	0,2924	0,9563	0,3057	3,2708	73
18	0,3090	0,9511	0,3249	3,0777	72
19	0,3256	0,9455	0,3413	2,9012	71
20	0,3420	0,9397	0,3640	2,7475	70
21	0,3584	0,9336	0,3839	2,6051	69
22	0,3746	0,9272	0,4040	2,4751	68
23	0,3907	0,9205	0,4245	2,3558	67
24	0,4067	0,9135	0,4452	2,2460	66
25	0,4226	0,9063	0,4663	2,1445	65
26	0,4384	0,8988	0,4877	2,0503	64
27	0,4540	0,8910	0,5095	1,9626	63
28	0,4695	0,8829	0,5317	1,8807	62
29	0,4848	0,8746	0,5543	1,8040	61
30	0,5000	0,8660	0,5774	1,7320	60
31	0,5150	0,8572	0,6009	1,6643	59
32	0,5299	0,8480	0,6249	1,6003	58
33	0,5446	0,8387	0,6494	1,5399	57
31	0,5592	0,8290	0,6745	1,4826	56
35	0,5736	0,8192	0,7002	1,4281	55
36	0,5878	0,8090	0,7265	1,3764	51
37	0,6018	0,7986	0,7536	1,3270	53
38	0,6157	0,7880	0,7813	1,2799	52
39	0,6293	0,7771	0,8098	1,2349	51
40	0,6128	0,7660	0,8391	1,1917	50
41	0,6561	0,7547	0,8693	1,1504	49
42	0,6691	0,7431	0,9004	1,1106	48
43	0,6820	0,7314	0,9325	1,0724	47
44	0,6947	0,7193	0,9657	1,0355	46
45	0,7071	0,7071	1,0000	1,0000	45
Градусы Degrees	cos	sin	ctg cotan	tg tan	Градусы Degrees

6. Converting Grid Azimuths to Angles of the First Quadrant

Grid azimuths are converted to angles of the first quadrant by the formulas presented in Table 52.

Table 52

Formulas for converting grid azimuths to angles of the first quadrant

Значение дирекционного угла α a	Четверть окружности b	Знаки приращения координат c		Формулы приведения дирекционного угла к углу I четверти d	Формулы перехода от угла I четверти к дирекционному углу e	Схема f
		Δx	Δy			
From to От 0° до 90°	I	+	+	$\alpha_1=\alpha$	$\alpha=\alpha_1$	
От 90° до 180°	II	−	+	$\alpha_1=180°-\alpha$	$\alpha=180°-\alpha_1$	
От 180° до 270°	III	−	−	$\alpha_1=\alpha-180°$	$\alpha=\alpha_1+180°$	
От 270° до 360°	IV	+	−	$\alpha_1=360°-\alpha$	$\alpha=360°-\alpha_1$	

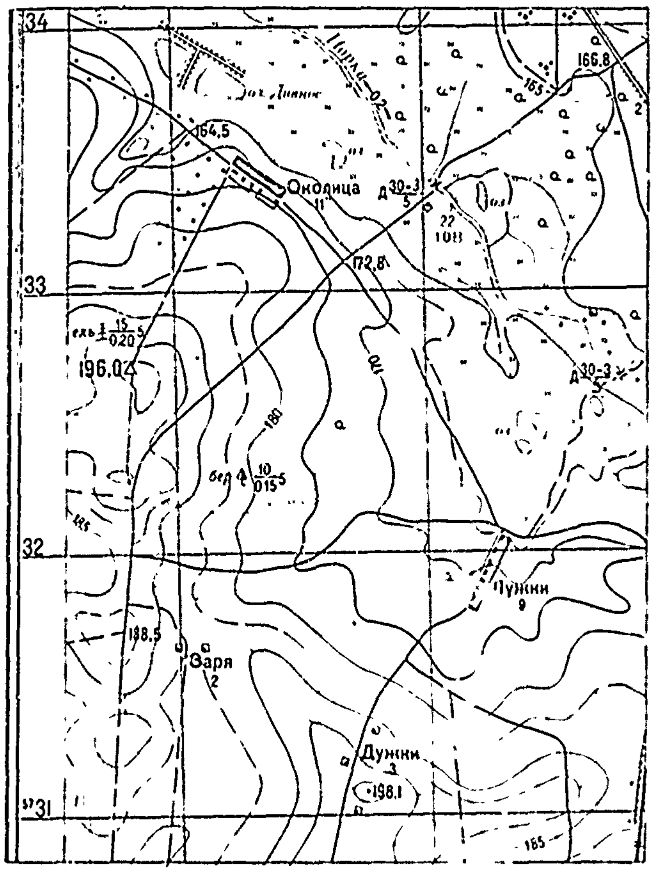
Key: a - value of grid azimuth, α; b - quadrant of circle; c - signs for increase in coordinates; d - formulas for converting grid azimuth to angle of first quadrant; e - formulas for converting from angle of first quadrant to grid azimuth; f - diagram.

APPENDICES

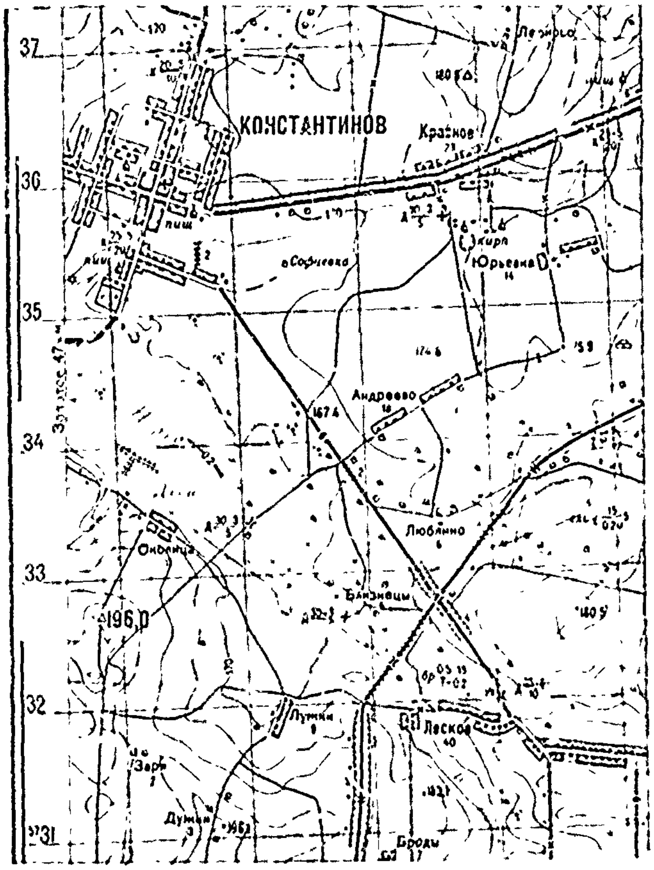
Appendix 1

SAMPLES OF TOPOGRAPHIC MAPS

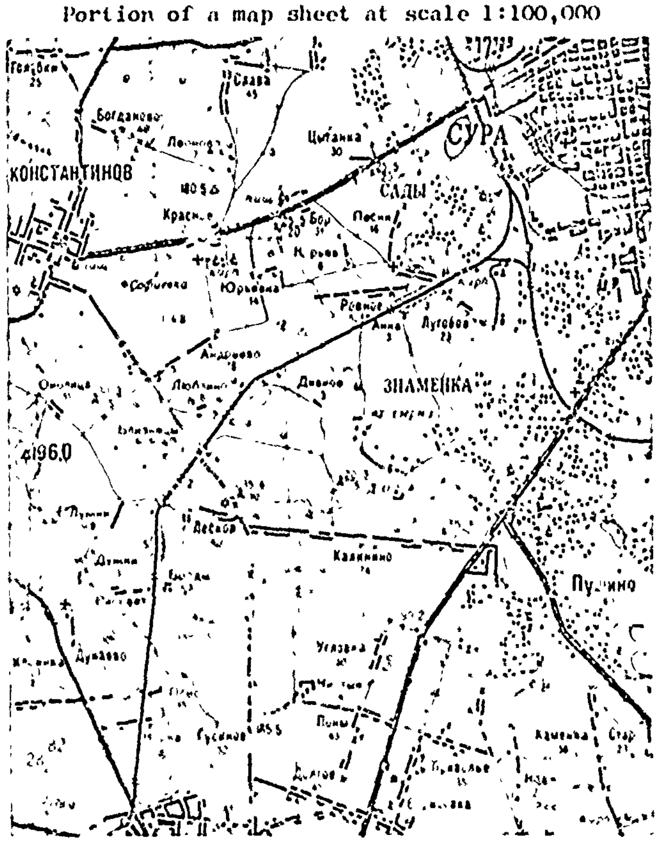
Portion of a map sheet at scale 1:25,000



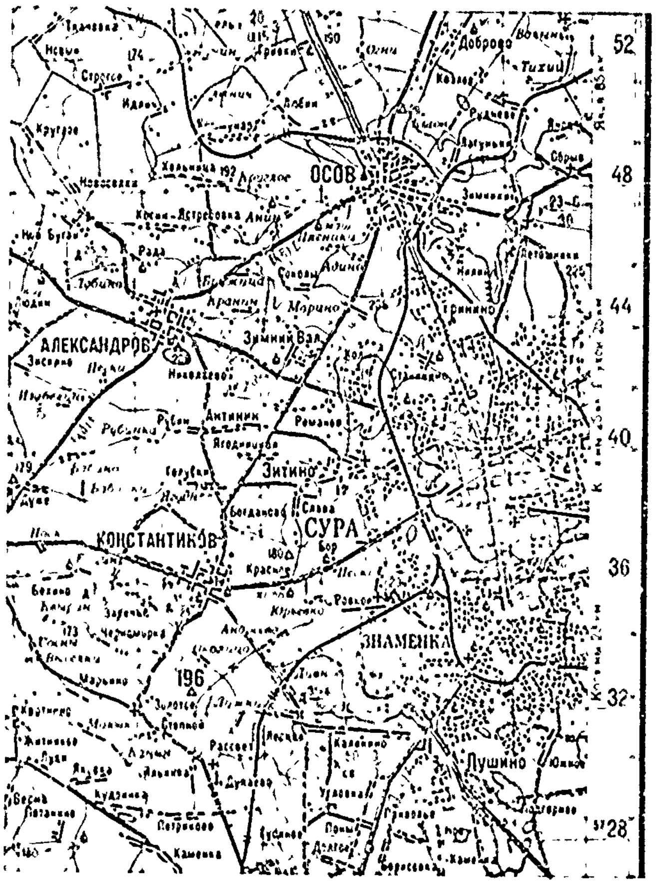
Portion of a map sheet at scale 1:50,000



Portion of a map sheet at scale 1:100,000

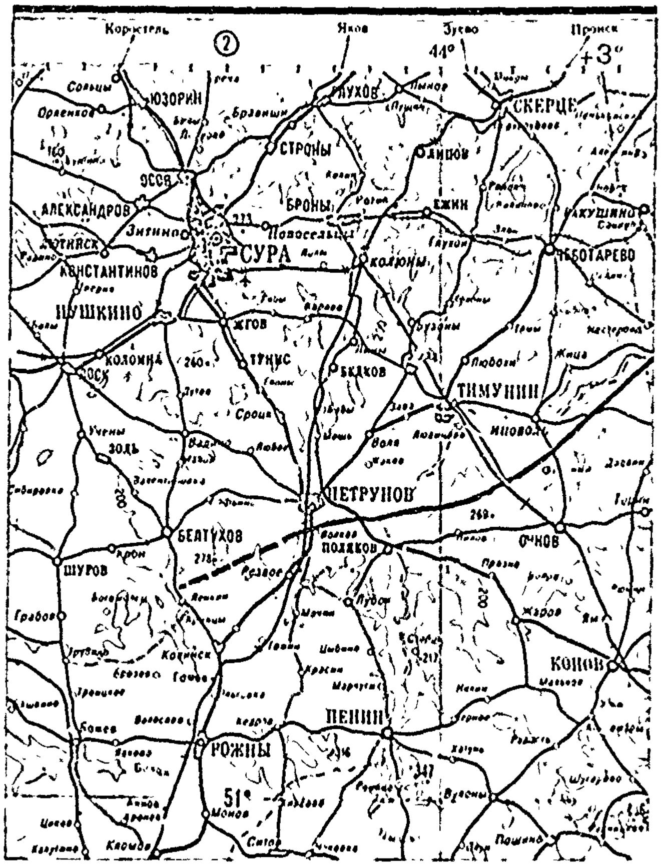


Portion of a map sheet at scale 1:200,000



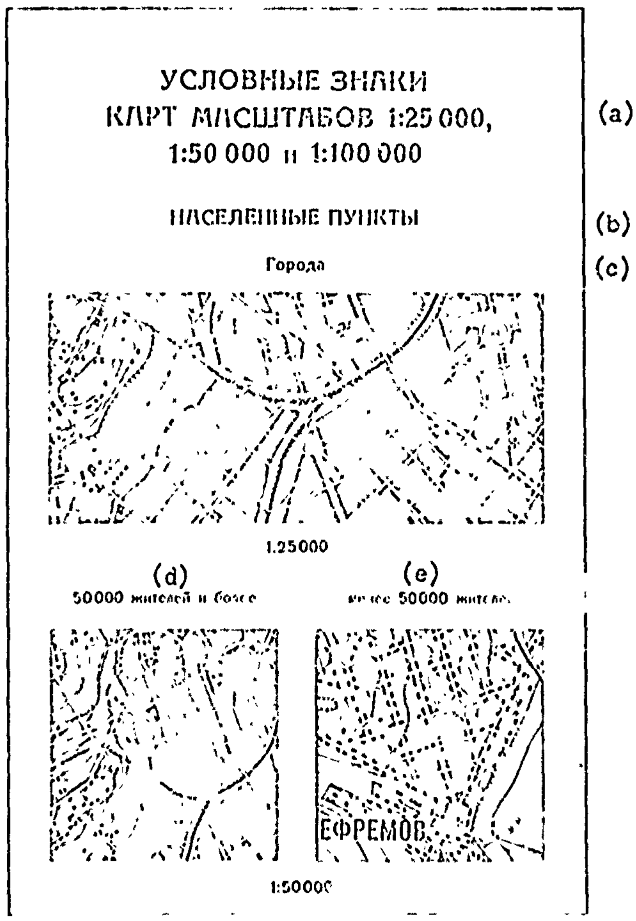
Portion of a map sheet at scale 1:500,000

Portion of a map sheet at scale 1:1,000,000

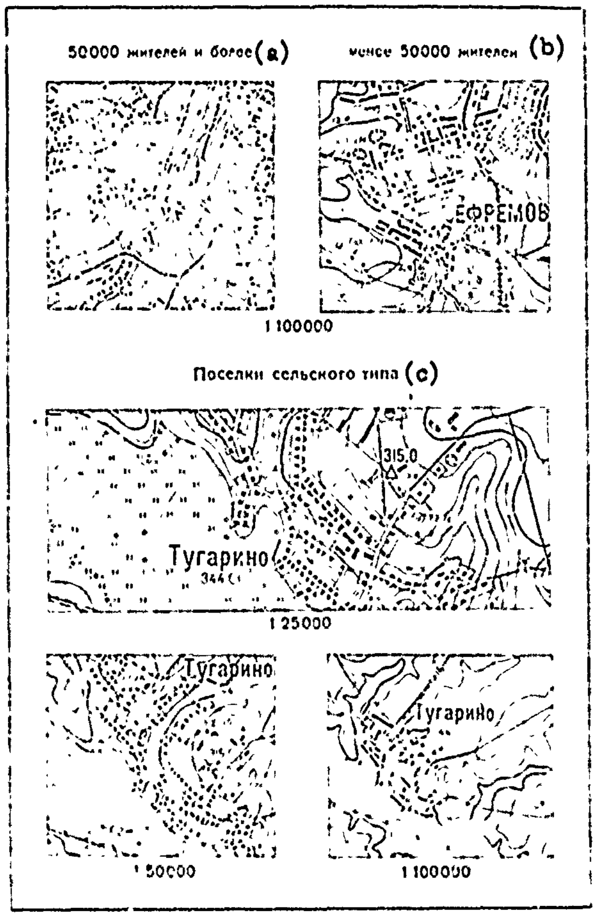


Appendix 2

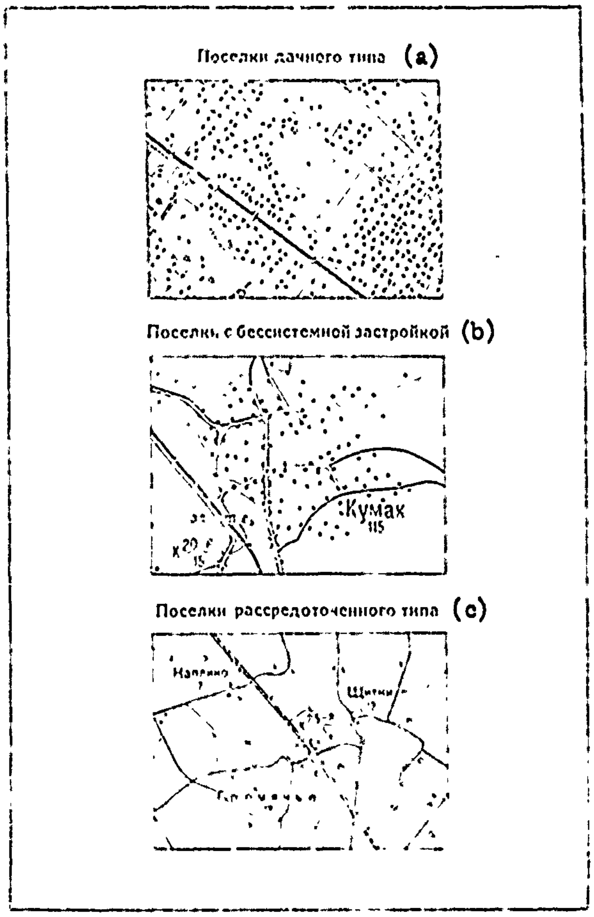
MAP SYMBOLS



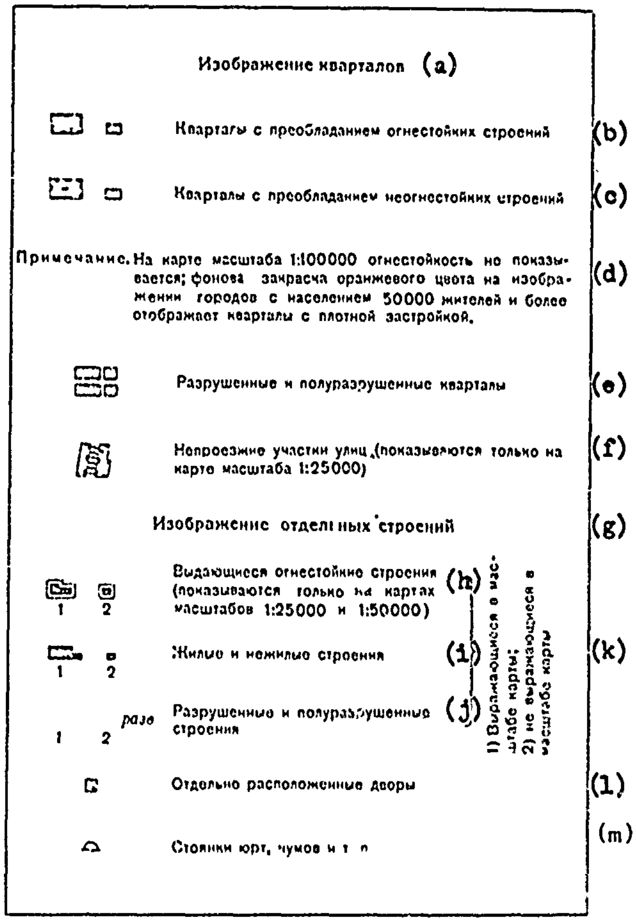
Key: a - conventional signs for maps of scales 1:25,000, 1:50,000, 1:100,000; b - populated places; c - cities; d - 50,000 or more residents; e - less than 50,000 residents.



Key: a - 50,000 or more residents; b - less than 50,000 residents;
c - rural-type settlements.



<u>Key</u>: a - suburban-type settlements; b - settlements with random structures; c - dispersed-type settlements.



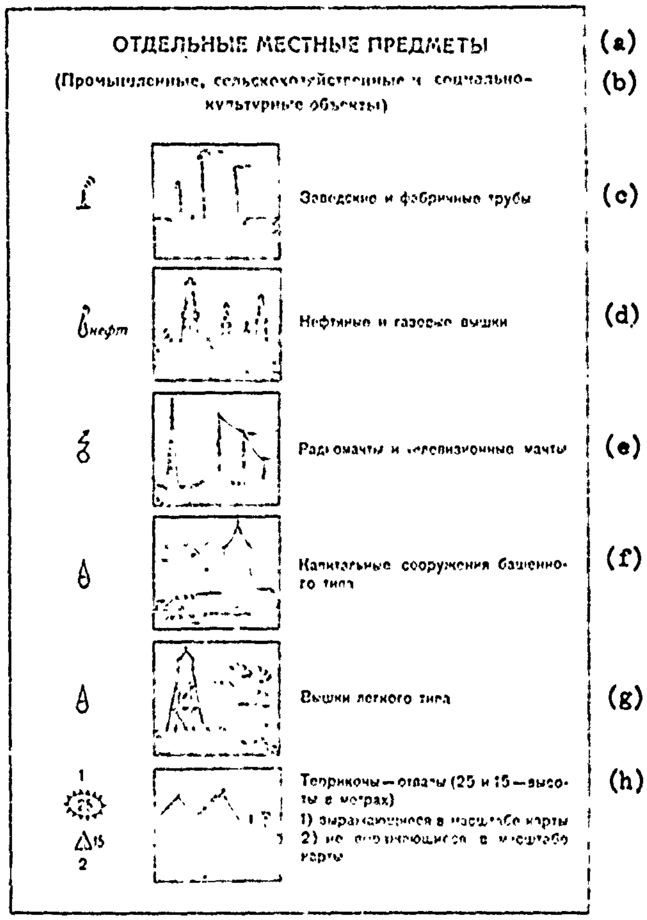
Key: a - representation of blocks; b - blocks with predominance of fire-resistant structures; c - blocks with predominance of non-fire resistant structures; d - Remarks: Fire resistance is not shown on a 1:100,000 map; the background coloring in orange in the representation of cities with a population of 50,000 residents or more portrays blocks with dense structure. e - destroyed and semidestroyed blocks; f - impassable sections of streets (shown only on a 1:25,000 map); g - representation of individual structures; h - prominent fire-resistant structures (shown only on maps with a scale of 1:25,000 and 1:50,000); i - residential and non-residential structures; j - destroyed and semidestroyed buildings; k - 1) expressed at map scale; 2) not expressed at map scale; l - separate courts; m - stopping places of nomad tents, tents of skin or bark, etc.

Подписи названий населенных пунктов		(a)
Города		(b)
МОСКВА	Столица СССР, столицы союзных республик СССР и столицы иностранных государств с населением свыше 1000000 жителей. Города с населением свыше 1000000 жителей	(c)
РИГА	Столицы союзных республик СССР и столицы иностранных государств с населением менее 1000000 жителей. Города с населением от 500000 до 1000000 жителей	(d)
ТОМСК	Столицы АССР, центры краев, областей и автономных областей, не входящих в состав края. Административные центры 1-го порядка на иностранной территории. Города с населением от 100000 до 500000 жителей	(e)
МАЙКОП	Центры областей и автономных областей, входящих в состав края. Центры национальных округов. Города с населением от 50000 до 100000 жителей	(f)
ТОРЖОК	Города с населением от 10000 до 50000 жителей	(g)
АЛЕКСИН	Города с населением от 2000 до 10000 жителей	(h)
ВАРНЯЙ	Города с населением менее 2000 жителей	(i)
Примечание.	Подписи названий населенных пунктов и железнодорожных станций показаны для карты масштаба 1:100000. На картах масштабов 1:25000 и 1:50000 эти подписи даются шрифтами того же вида, но несколько крупнее.	(j)

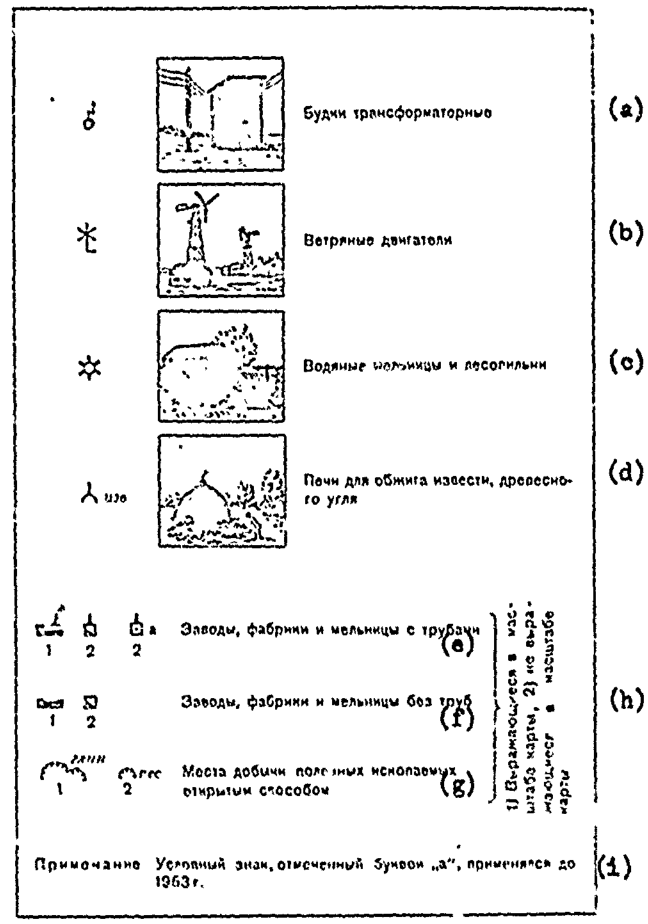
Key: a - names of populated places; b - cities; c - MOSCOW - The capital of the USSR, the capitals of union republics of the USSR, and the capitals of foreign states with a population of more than 1,000,000 residents. Cities with a population of more than 1,000,000 residents; d - RIGA - capitals of union republics of the USSR and capitals of foreign states with a population of less than 1,000,000 inhabitants. Cities with a population of from 500,000 to 1,000,000 inhabitants; e - TOMSK - capitals of associated Soviet Socialist Republics, kray centers, and centers of oblasts and autonomous oblasts which are not part of a kray. Administrative centers of the first category on foreign territory. Cities with a population of from 100,000 to 500,000 inhabitants; f - MAYKOP - Centers of oblasts which are part of a kray. Centers of national okrugs. Cities with a population of from 50,000 to 100,000 inhabitants; g - Torzhok - cities with a population of from 10,000 to 50,000 inhabitants; h - Aleksin - cities with a population of from 2,000 to 10,000 inhabitants; i - Varnyay - cities with a population of less than 2,000 inhabitants; j - Remarks: The names of populated places and railroad stations are shown for maps with a scale of 1:100,000. On 1 25,000 and 1:50,000 maps, these names are given in type of the same kind but somewhat larger.

Поселки городского типа (рабочие, курортные и пр.)		(a)
КОДЖОРИ	2000 жителей и более	(b)
ДУБКИ	менее 2000 жителей	(c)
Поселки при промышленных предприятиях, железнодорожных станциях, пристанях и т. п.		(d)
Майский	более 1000 жителей	(e)
Артемовский	от 100 до 1000 жителей	(f)
Рудничный	менее 100 жителей	(g)
Поселки сельского и дачного типа		(h)
Лабинская	более 200 домов	(i)
Гончаровка	от 100 до 200 домов	(j)
Юрьевка	от 20 до 100 домов	(k)
Лотошино	менее 20 домов	(l)
Динская	Отдельные дворы	(m)
Железнодорожные станции		(n)
Горбачево	Узловые и большие станции	(o)
Навтлуг	Станции, разъезды, платформы и остановочные пункты	(p)
Примечание. Если на карте название населенного пункта подчеркнуто, то оно относится и к ближайшей железнодорожной станции или речной пристани.		(q)

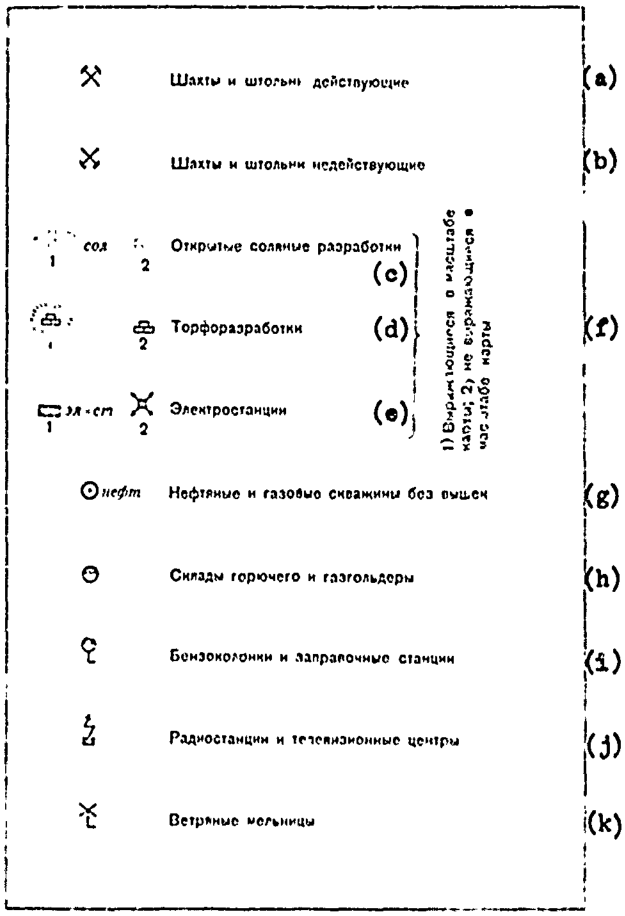
Key: a - city-type settlements (workers', health resort, etc.); b - Kodzhori - 2,000 residents or more; c - Dubki - less than 2,000 inhabitants; d - settlements with industrial enterprises, railroad stations, landings, etc.; e - Mayskiy - more than 1,000 inhabitants; f - Artemovskiy - from 100 to 1,000 inhabitants; g - Rudnichnyy - less than 100 inhabitants; h - rural and suburban-type settlements; i - Labinskaya - more than 200 houses; j - Goncharovka - from 100 to 200 houses; k - Yur'yevka - from 20 to 100 houses; l - Lotoshino - less than 20 houses; m - Dinskaya - individual courtyards; n - railroad stations; o - Gorbachevo - junctions and large stations; p - Navtlug - stations, sidings, platforms, and stopping points; q - Remarks: If the name of a populated place is underlined on a map, it also pertains to the nearest railroad station or river landing.



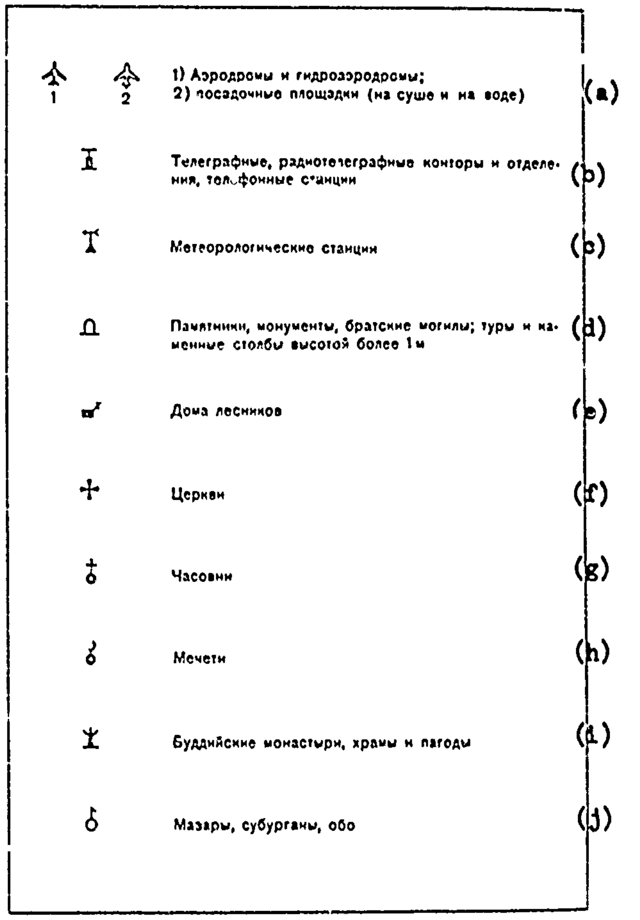
Key: a - individual local objects; b - (industrial, agricultural, and socio-cultural objects); c - plant and factory smokestacks; d - oil and gas towers; e - radio towers and television towers; f - turret-type substantial structures; g - light-type tower; h - waste piles - tailings (25 and 15 - heights in meters): 1) expressed at map scale; 2) not expressed at map scale.



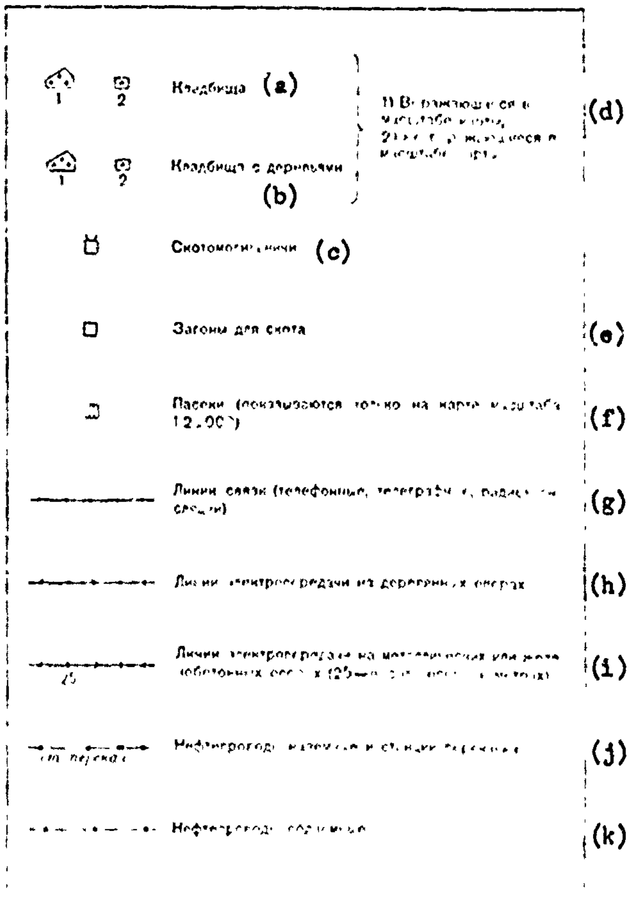
Key: a - transformer vault; b - windmills; c - water mills and sawmills; d - ovens for kilning lime, charcoal; e - plants, factories, and mills with smokestacks; f - plants, factories, and mills without smokestacks; g - sites for mining minerals by the open method; h - 1) expressed at map scale - clay indicated; 2) not expressed at map scale - sand indicated; i - Remarks: A symbol marked with the letter "a" was used until 1963.



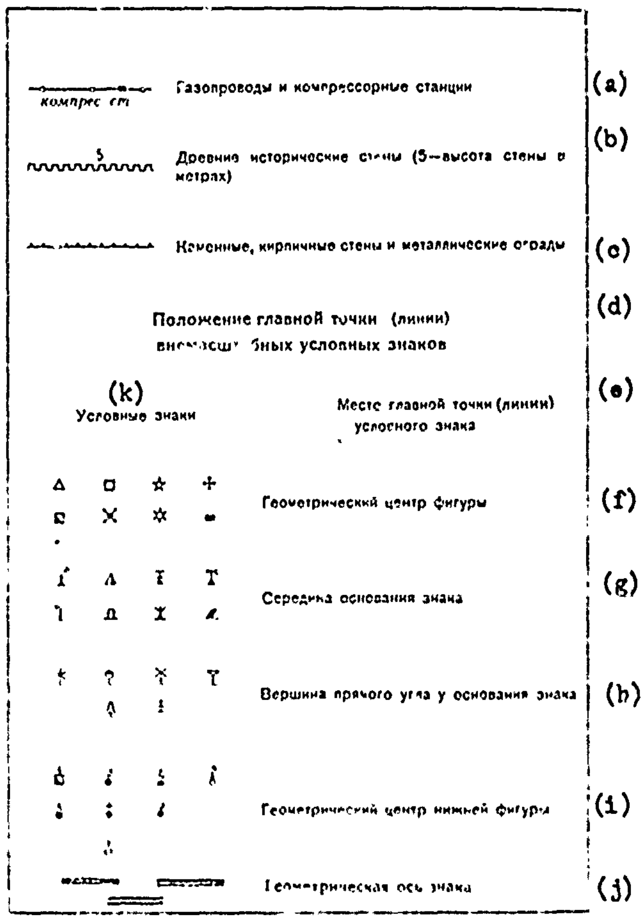
Key: a - operating mines and galleries; b - inoperative mines and galleries; c - open salt works; d - pea' works; e - electric power stations; f - 1) expressed at map scale; 2) not expressed at map scale; g - oil and gas wells without towers; h - fuel storage areas and gas tanks; i - gasoline pumps and filling stations; j - radio stations and television centers; k - windmills.



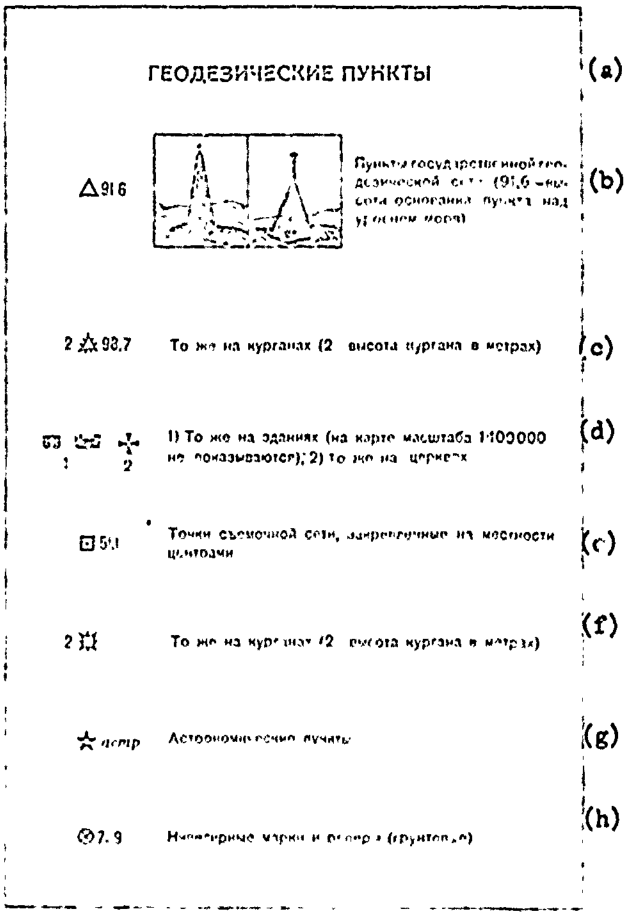
Key: a - 1) airports and seaplane stations, 2) landing areas (on land and on water); b - telegraph, radiotelegraph circuits and branches, telephone stations; c - meteorological stations; d - memorials, monuments, common graves; cairns and stone columns more than 1 meter high; e - forester's houses; f - churches; g - chapels; h - mosques; i - Buddhist monasteries, temples and pagodas; j - tombs, shrines, burial mounds.



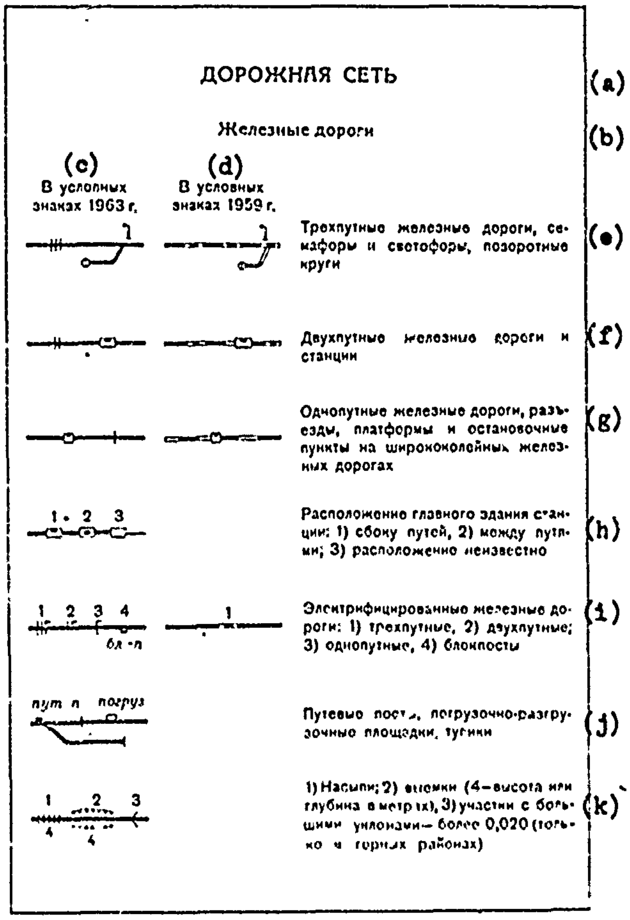
Key: a - cemeteries; b - cemetery with trees; c - cattle burial farm; d - 1)expressed at map scale; 2) not expressed at map scale; e - cattle pens; f - apiaries (shown only on a 1:25,000 map); g - communications lines (telephone, telegraph, radio-relay); h - electrical transmission lines on wooden supports; i - electrical transmission lines on metal or ferroconcrete supports (25 - the height of support in meters); j - ground oil pipelines and pumping station - pumping station indicated; k - underground oil pipeline.



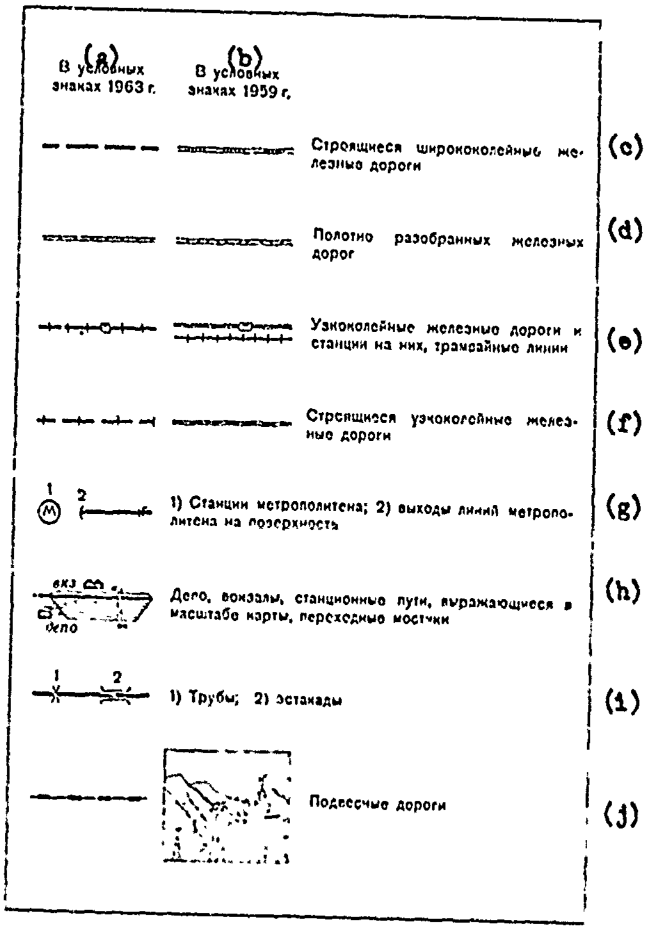
Key: a - gas lines and compressor stations - compressor station indicated; b - ancient historical walls (5 - height of wall in meters); c - stone or brick walls and metal fences; d - position of main point (line) of symbols which are not to scale; e - location of the main point (line) of symbol; f - geometric center of figure; g - middle of base of symbol; h - top of straight line at base of symbol; i - geometric center of lower figure; j - geometric axis of symbol; k - symbols.



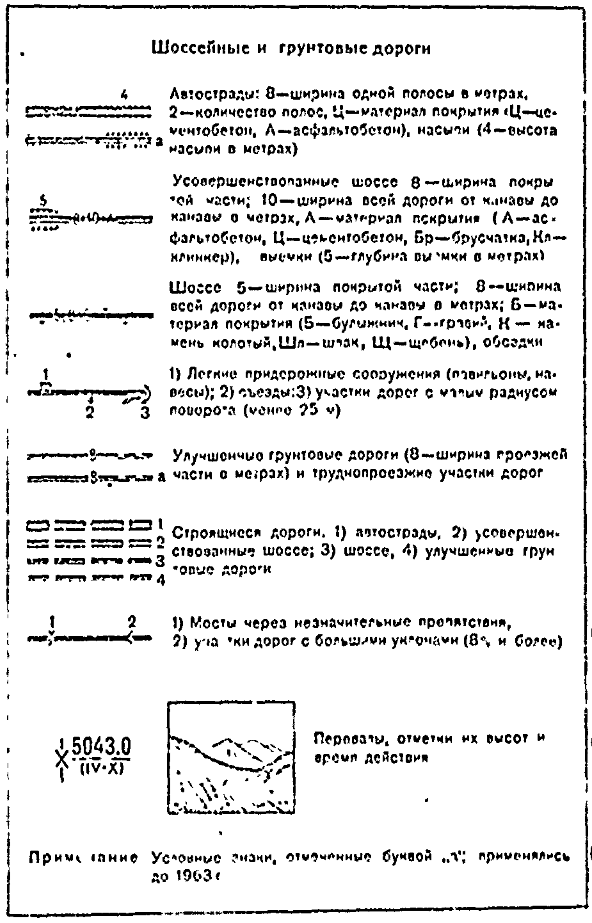
Key: a - Geodetic points; b - points of state geodetic net (91.6 - altitude of base of point above sea level); c - the same on mounds (2 - height of mound in meters); d - 1) the same on buildings (not shown on a 1:100,000 map), 2) the same on churches; e - points of a survey net tied to the terrain with their centers; - the same on mounds (2 - height of mound in meters); g - astronomic points; h - leveling mark and bench marks (ground).



Key: a - Road net; b - railroa[illegible] c - in 1963 symbols; d - in 1959 symbols; e - three-way railroad[illegible] semaphores, signal lights, turn table; f - two-way rail[illegible] a[illegible] stations; g - single-track railroads, sidings, platform[illegible] [illegible]ping points on wide-gauge railroads; h - disposition of m[illegible] [illegible]ildings of a station: 1) to the side of the right-of-way; 2) [illegible]ween the tracks; 3) location unknown; i - electrified railroads: 1) three-way; 2) two-way; 3) single track; 4) block house; j - track post (left); loading-unloading areas (right); deadends; k - 1) embankments; 2) depressions (4 - height or depth in meters); 3) sectors with great slopes - more than 0.020 (only in mountain regions).

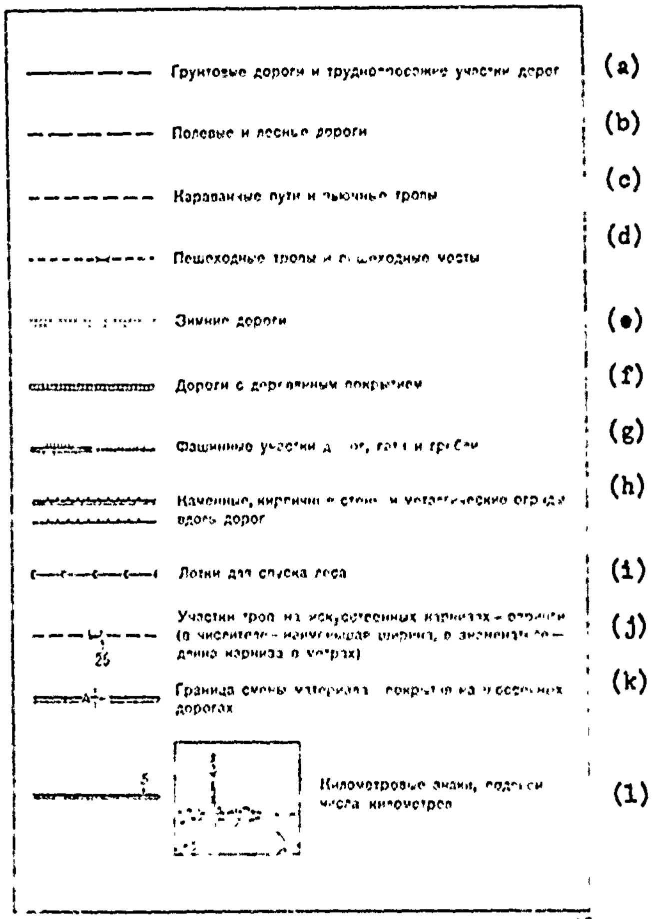


Key: a - in 1963 symbols; b - in 1959 symbols; c - wide-gauge railroads under construction; d - roadbed of dismantled railroads; e - narrow-gauge railroads and stations on them, streetcar lines; f - narrow-gauge railroads under construction; g - 1) subway stations; 2) exists to the surface from subway lines; h - depots, stations, station tracks expressed at map scale, small cross-over bridges; i - 1) pipes; 2) trestles; j - aerial trolleys.

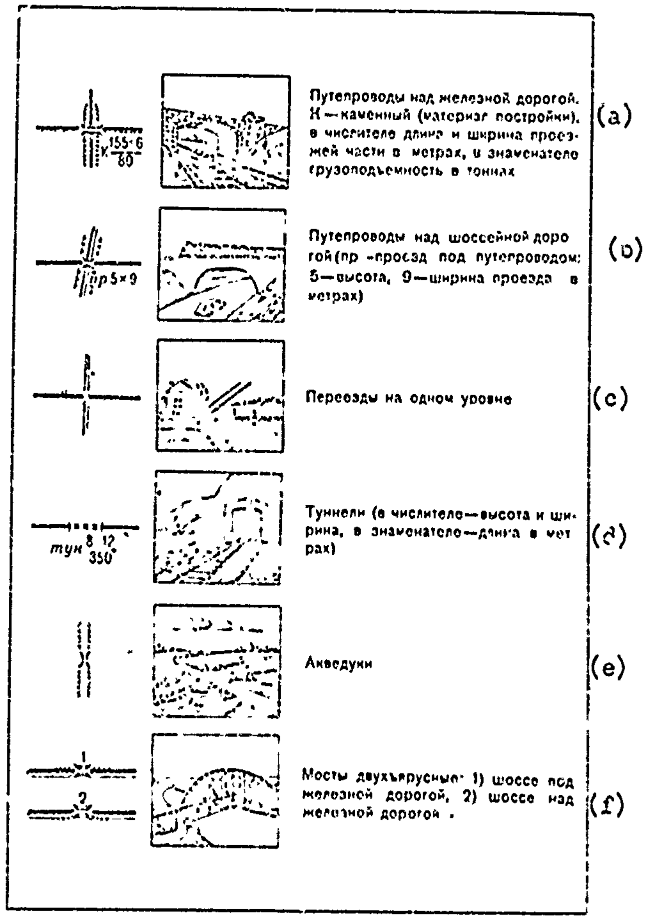


(a) (b) (c) (d) (e) (f) (g) (h) (i) (j)

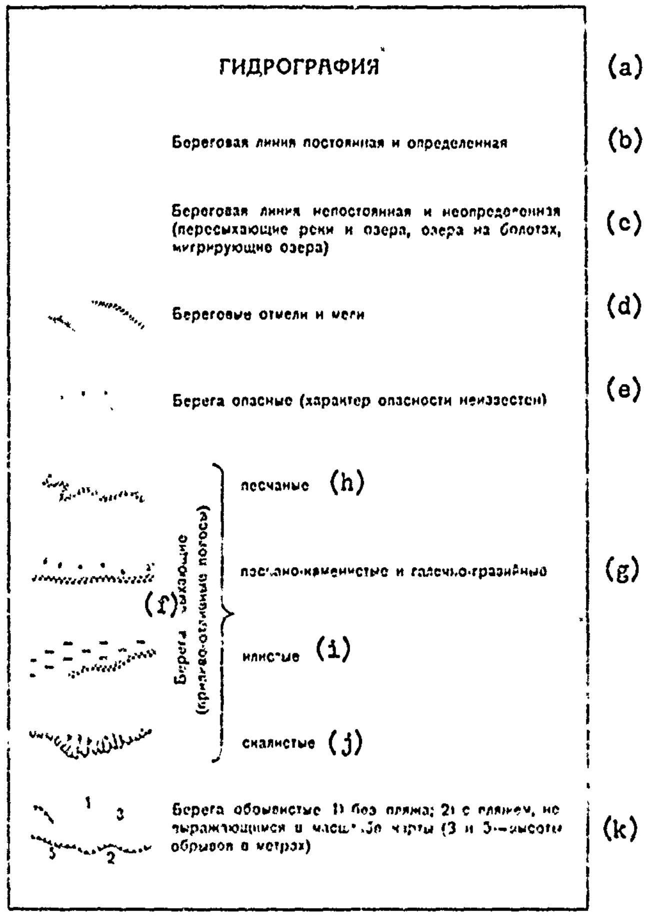
<u>Key</u>: a - Highways and dirt roads; b - superhighways: 8 - width of one lane in meters, 2 - number of lanes, Ts - surfacing material (Ts - cement-concrete, A - asphalt-concrete), embankments (4 - height of embankment in meters); c - improved highway: 8 - width of surfaced part, 10 - width of entire road from ditch to ditch in meters, A - surfacing material (A - asphalt-concrete, Ts - cement-concrete, Br - blocks, Kl - clinker), depressions (5 - depth of depression in meters); d - highway: 5 - width of surfaced part, 8 - width of entire road from ditch to ditch in meters, B - surface material (B - cobblestone, G - gravel, K - crushed stone, Shl - slag, Shch - broken stone); plantings; e - 1) light road-side structures (pavilions, sheds), 2) descents, 3) road sectors with small turning radius (less than 25 meters); f - improved dirt roads (8 - width of roadway in meters) and road sectors difficult to negotiate; g - roads under construction: 1) superhighways, 2) improved highways, 3) highways, 4) improved dirt roads, h - 1) bridges across insignificant obstacles, 2) sectors of roads with large slopes (8% or more); i - passes, their altitude readings and time in effect; j -
<u>Remarks</u>: Symbols marked with the letter "a" were used prior to 1963.



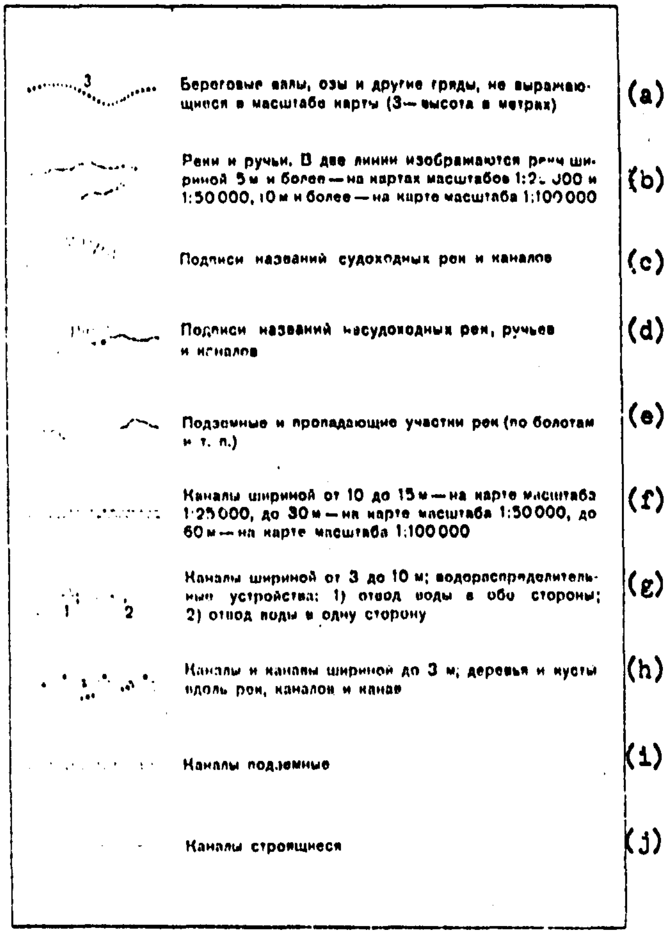
<u>Key</u>: a - dirt roads and road sections difficult to negotiat- b - field and forest roads; c - caravan and pack trails; d - foot paths and foot bridges; e - winter roads; f - roads with wooden surfacing; g - fascined sectors of road, dams and causeways; h - stone and brick walls and metal fences along the road; i - flumes for lowering timber; j - sectors of paths on artificial cornices - suspended mountain log trails (in the numerator -smallest width, in the denominator - length of cornice in meters); k - boundary of change in surfacing material on highways; l - kilometer signs, numbers - the number of kilometers.



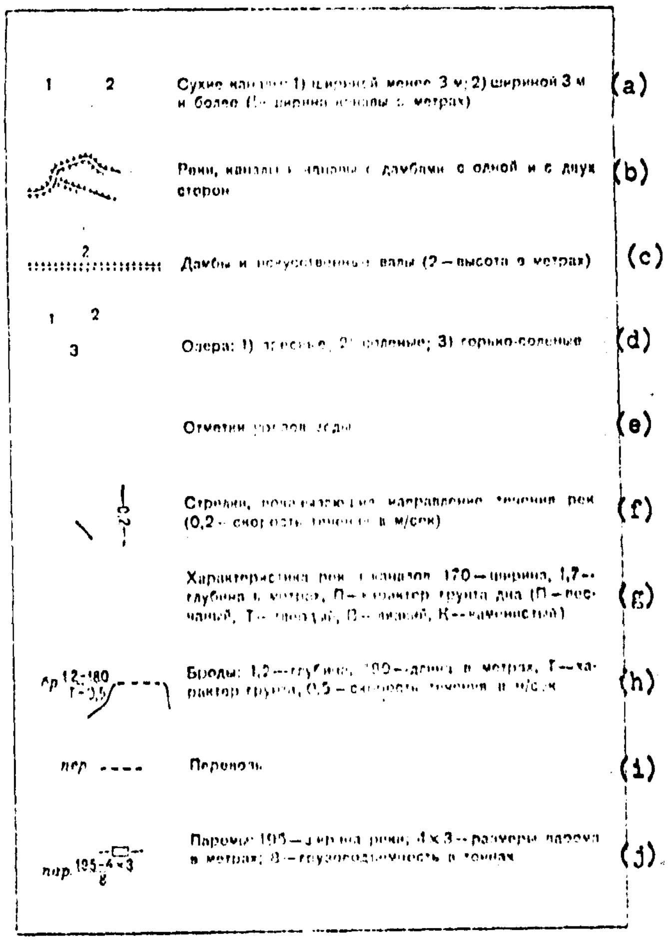
Key: a - viaducts over a railroad: K - stone (construction material), in the numerator, the length and w'dth of roadway in meters, in the denominator, load capacity in tons; b - viaducts over a highway (np passage beneath viaduct: 5 - height, 9 - widtn of passage in meters); c - grade crossing; d - tunnels (in the numerator - height and width, in the denominator - length in meters); e - aquaduct; f - double-decked bridges: 1) highway under railroad, 2) highway above railroad.



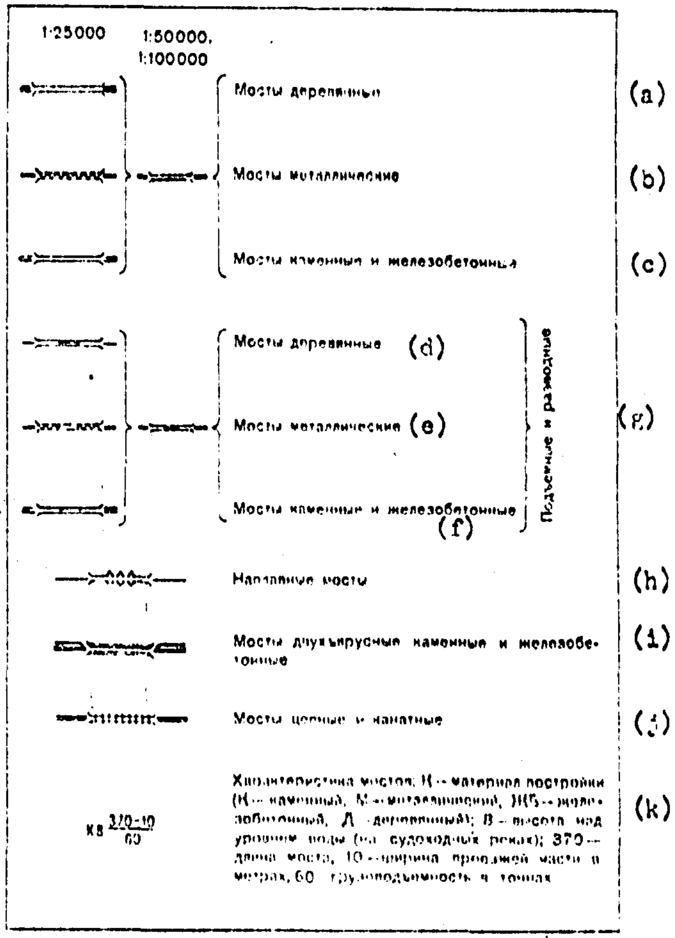
Key: a - Hydrography; b - shore line permanent and determined; c - shore line not permanent and undetermined (dried-out rivers and lakes, lakes in swamps, migratory lakes); d - shore shoals and sandbanks; e - dangerous shores (nature of danger unknown); f - drying banks (ebb and flow zones); g - sandy-stoney and pebbly-gravel; h - sandy; i - muddy; j - rocky; k - shores precipitous: 1) without beach, 2) with beach, not expressed at map scale (3 and 5 - heights of precipices in meters).



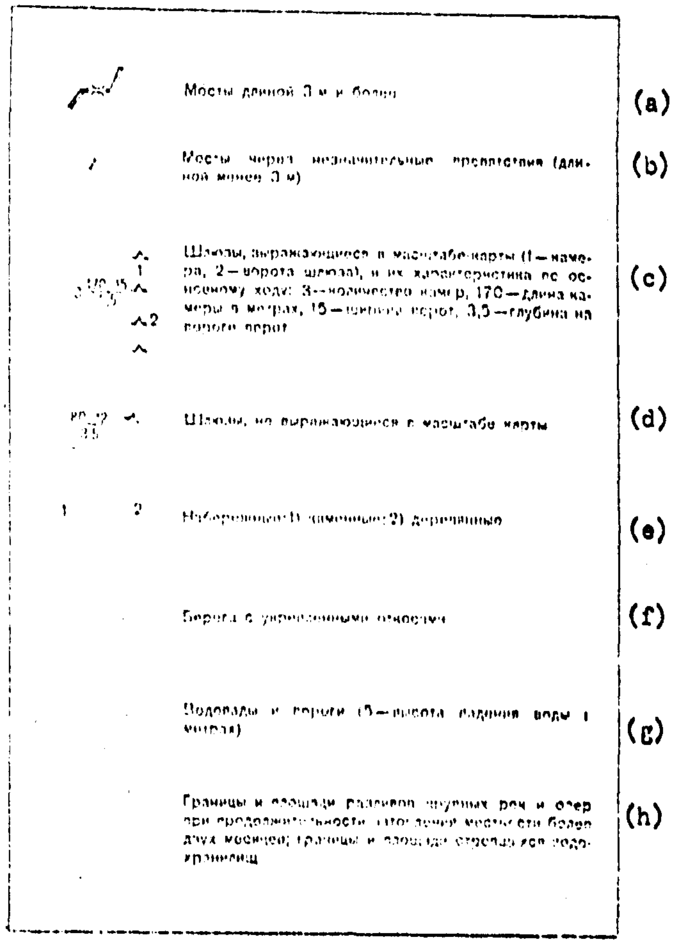
Key: a - shore embankments, eskers, and other ridges not expressed at map scale (3 - height in meters); b - rivers and streams. Two lines express rivers 5 meters or more wide, on 1:25,000 and 1:50,000 maps, 10 meters or more on 1:100,000 maps; c - label of names of navigable rivers and canals; d - label of names of unnavigable rivers, streams, and canals; e - underground and disappearing sections of rivers (through swamps, etc.); f - canals from 10 to 15 meters wide, on 1:50,000 maps, up to 30 meters on 1:50,000 maps, up to 60 meters on 1:100,000 maps; g - canals from 3 to 10 meters wide, water-distributing devices: 1) tapping water to both sides, 2) tapping water to one side; h - canals and ditches up to 3 meters wide, trees and bushes along the river, canals, and ditches; i - underground canals; j - canals under construction.



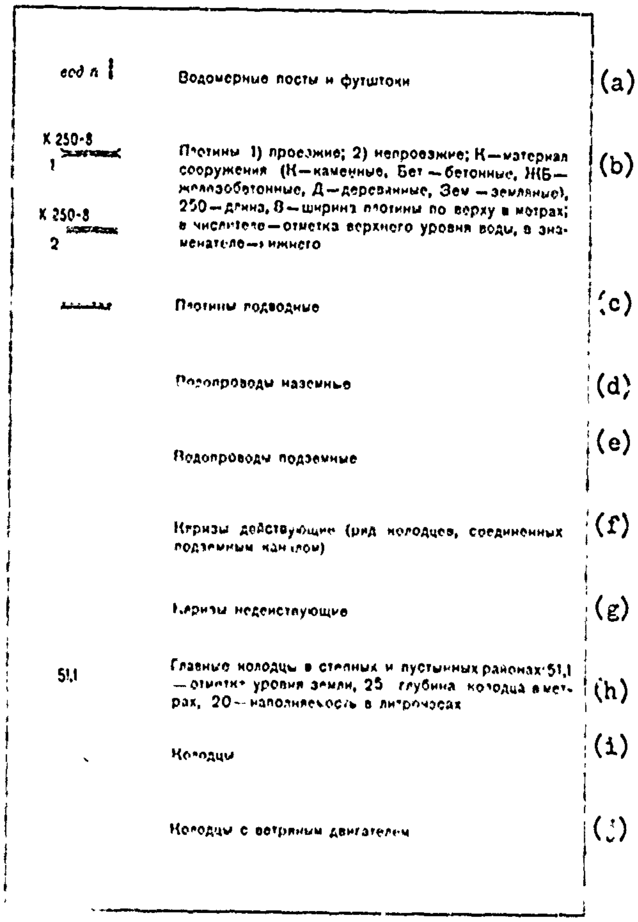
Key: a - dry ditches: 1) less than 3 meters wide, 2) 3 meters wide or more (5 - width of ditch in meters); b - rivers, canals, and ditches with dams on one and on two sides; c - dams and artificial embankments (2 - height in meters); d - lakes: 1) fresh water, 2) salt water, 3) bitter salty; e - altitude readings of water's edge; f - arrows showing the direction of river currents (0.2 - speed of current in meters/sec); g - characteristics of rivers and canals: 170 - width, 1.7 - depth in meters, P - nature of bottom soil) P - sandy, T - hard, B - viscous, K - rocky); h - fords: 1.2 - depth, 180 - length in meters, T - character of the ground, 0.5 - speed of current in meters/second; i - transport; j - ferries: 195 - width of river, 4x3 - dimensions of ferry in meters, 8 - load capacity in tons.



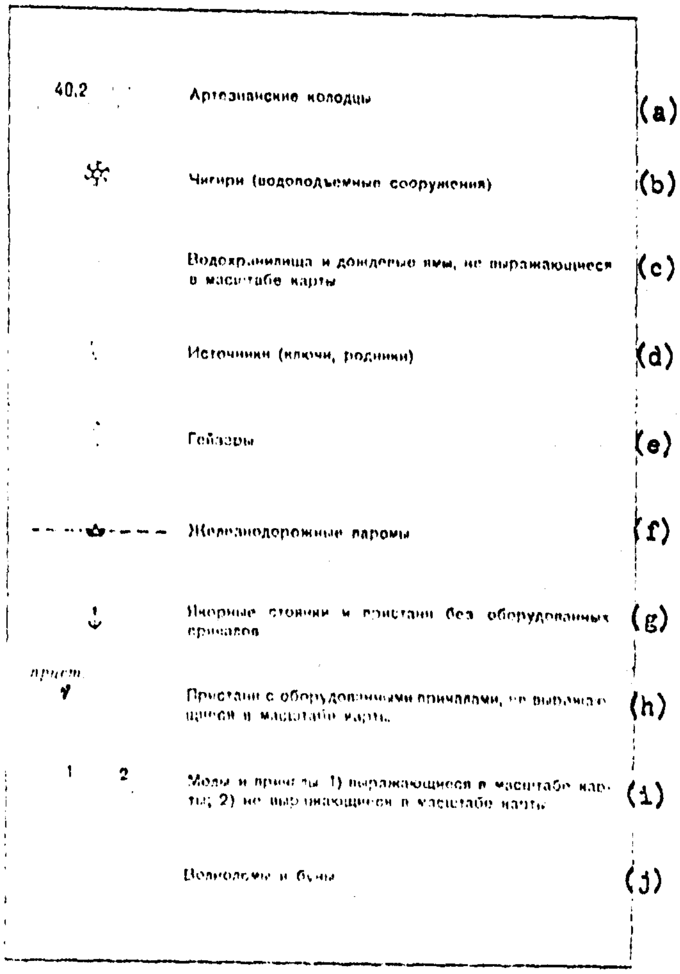
Key: a - wooden bridges; b - metal bridges; c - stone and ferroconcrete bridges; d - wooden bridges; e - metal bridges; f - stone and ferroconcrete bridges; g - draw and swing bridges; h - floating bridges; i - double-decked stone and ferroconcrete bridges; j - chain and rope bridges; k - bridge characteristics: K - construction materials (K - stone, M - metal, ZhB - ferroconcrete, D - wooden), 8 - height above water level (on navigable rivers), 370 - length of bridge, 10 - width of roadway in meters, 60 - load capacity in tons.



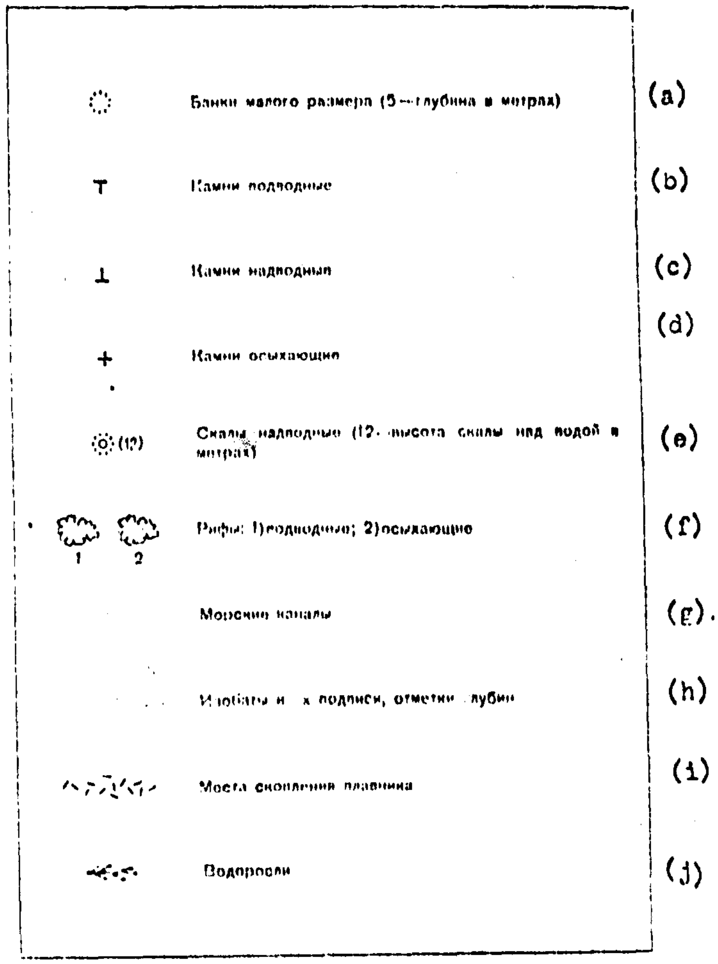
Key: a - bridges 3 meters long, or more; b - bridges across insignificant obstacles; c - sluices expressed at map scale (1 - chamber, 2 - gates of sluice) and their characteristics along the main course: 3 - number of chambers, 170 - length of chamber in meters, 15 - width of gate, 3.5 - depth at threshold of gate; d - sluices not expressed at map scale; e - quays: 1) stone, 2) wooden; f - banks with reinforced inclines; g - waterfalls and rapids (5 - height of waterfall in meters); h - limits and areas of inundations of large rivers and lakes with a duration of inundation of the terrain for more than 2 months, limits and areas of reservoirs under construction.



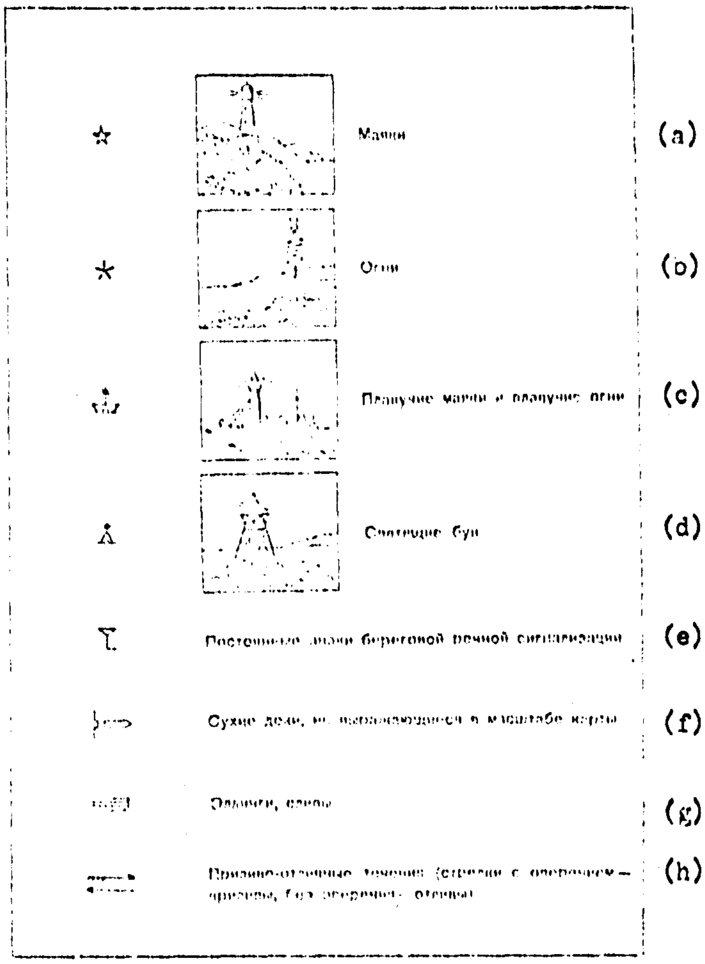
Key: a - water-measuring posts and depth gauge; b- dams: 1) passable, 2) impassable, K - construction material (K - stone, Bet - concrete, ZhB - ferroconcrete, D - wooden, Zem - dirt), 250 - length, 8 - width of dam along the top in meters. In the numerator, height reading of upper water level, in the demonimator, the lower level; c - underwater dams; d - water pipes on the ground; e - underground water pipes; f - operating underground water conduit with wells (a series of wells connected by an underground canal); g - same as f, but inoperative; h - main wells in steppe and desert regions: 51.1 - altitude reading of ground level, 25 - depth of well in meters, 20 - fillability in liter-hours; i - wells; j - wells with windmill.



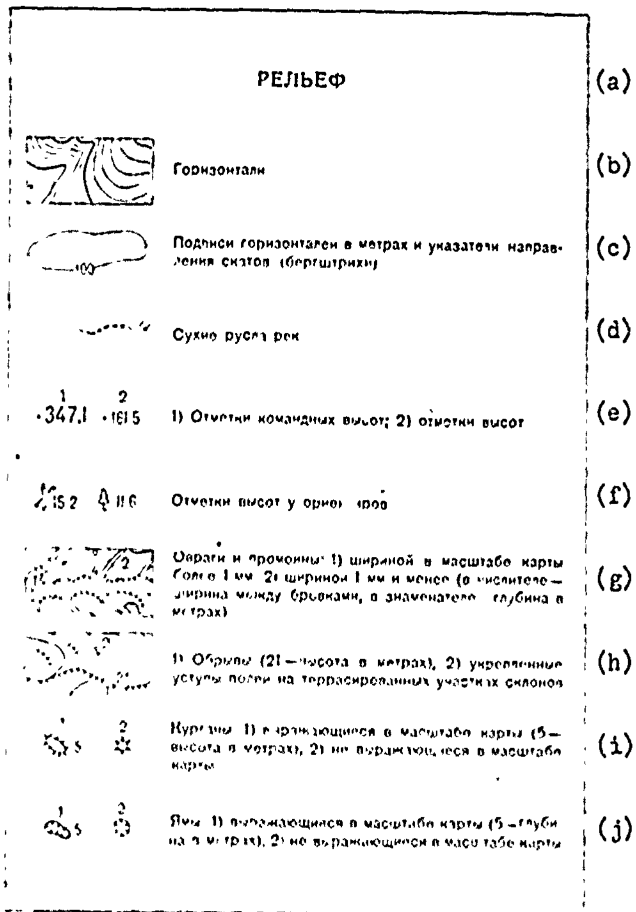
Key: a - artesian wells; b - water wheels (structures for raising water); c - reservoirs and rain pits not expressed at map scale; d - springs (fountains, sources); e - geysers; f - railroad ferries; g - anchorages and piers without improved moorings; h - wharves with moorings installed but not expressed at map scale; i - jetties and wharves: 1) expressed at map scale, 2) not expressed at map scale; j - breakwaters and dike dams.



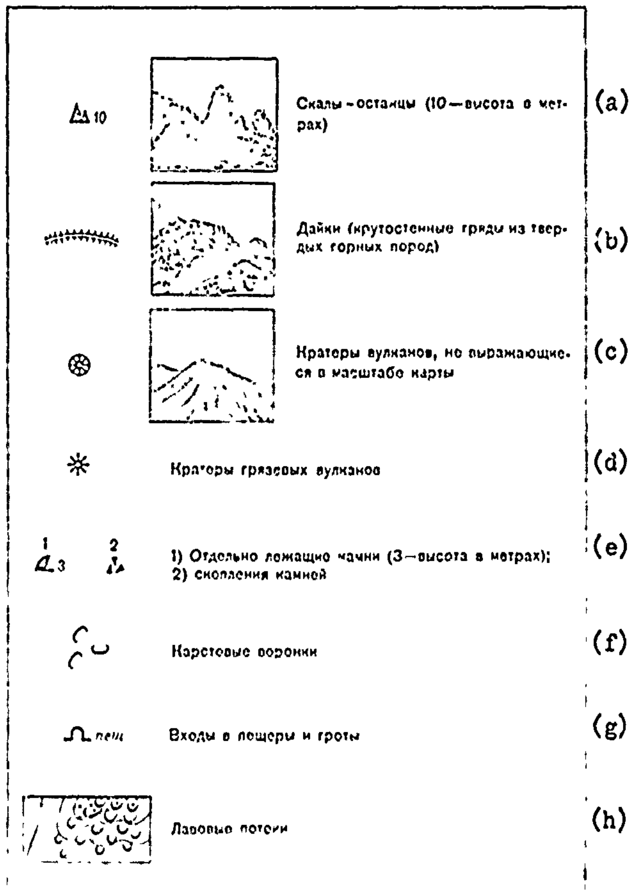
Key: a - small-sized banks (5 - depth in meters); b - underwater rocks; c - rocks above the water; d - drying rocks; e - rocks above water (12 - height of rock above water in meters); f - reefs: 1) underground, 2) drying; g - sea channels; h - isobaths and their values, depth readings; i - sites of accumulation of drift-wood; j - seaweed.



Key: a - beacons; b - lights; c - floating beacons and floating lights; d - light buoys; e - permanent river bank signal markers; f - drydocks not expressed at map scale; g - slipways, slips; h - ebb and flow currents (arrows with tails - flow, without tails - ebb).

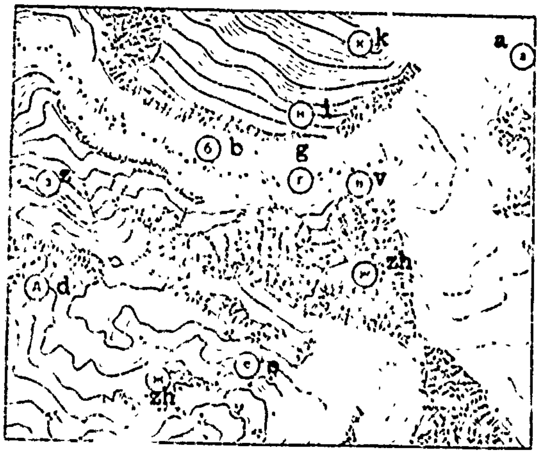


Key: a - Relief; b - contour lines; c - label of contour line in meters and indicators of direction of slopes (hachures indicating slope); d - dry river channels; e - 1) altitude readings of commanding heights, 2) altitude readings; f - altitude readings at reference points; g - gullies and washouts: 1) width at map scale greater than 1 mm, 2) width 1 mm or less (in the numerator - width between brows, in the denominator - depth in meters); h - 1) precipices (21 - height in meters), 2) reinforced shelfs of fields on terraced sectors of slopes; i - mounds: 1) expressed at map scale (5 - height in meters), 2) not expressed at map scale; j - pits: 1) expressed at map scale (5 - depth in meters); 2) not expressed at map scale.



Key: a - cliffs - monadnocks (10 - height in meters); b - dikes (steep-walled ridges of hard rock); c - volcano craters not expressed at map scale; d - craters of mud volcanoes; e - 1) rocks laying separately (3 - height in meters), 2) accumulation of rocks; f - karst craters; g - entrances to caves and caverns; h - lava flow.

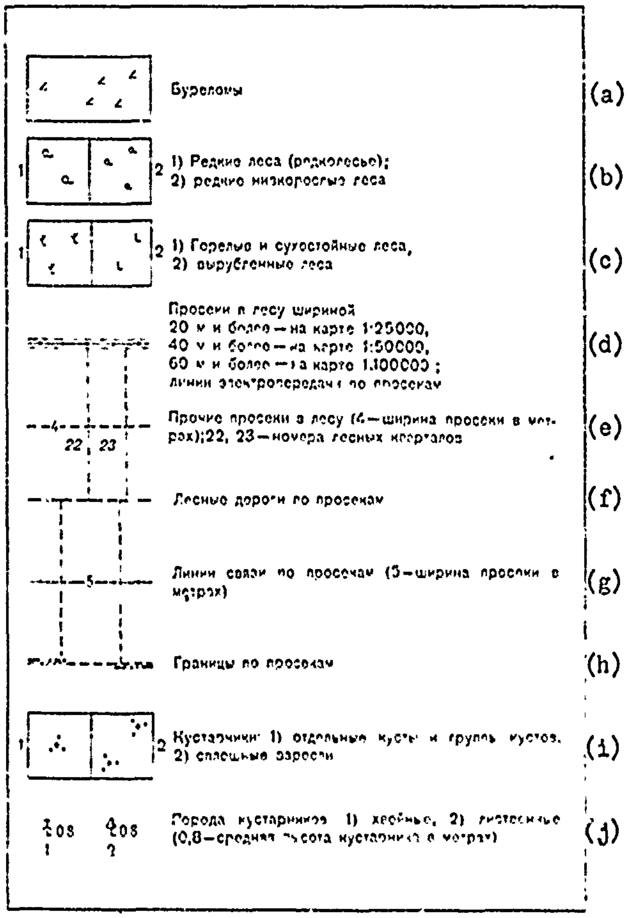
Representation of certain relief elements on maps.



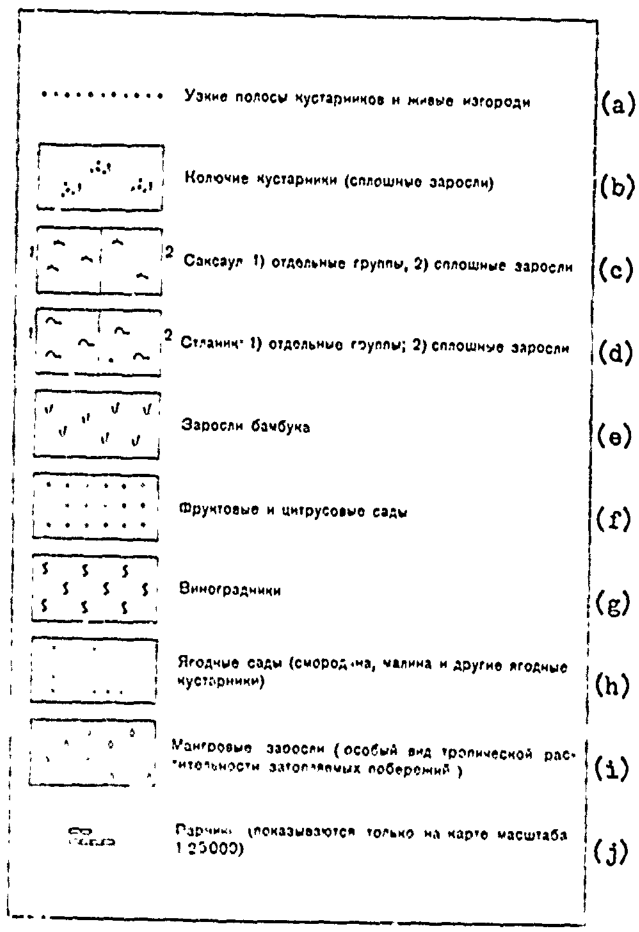
Key: a - firn fields (eternal snows); b - glaciers; v - crevasses; g - moraines; d - stone rivers; e - rock streams; zh - cliffs and rocky precipices; z - steep slopes which extend for less than 1 cm at map scale; i - steep slopes which extend for more than 1 cm at map scale; k - limits of firn fields.

Key: a - sod-covered terraces (brows) not expressed by contour lines; b - earth creeps; c - sand and dirt talus; d - stone and gravel talus; e - layers of ice; f - glacial scarps (barriers) and fossil ice (7 - height of escarpment in meters); g - plant cover and soils; h - coniferous trees (spruce, fir, pine, cedar, larch, and others - pine shown); i - deciduous trees (oak, beech, maple, birch, aspen, and others - maple shown).

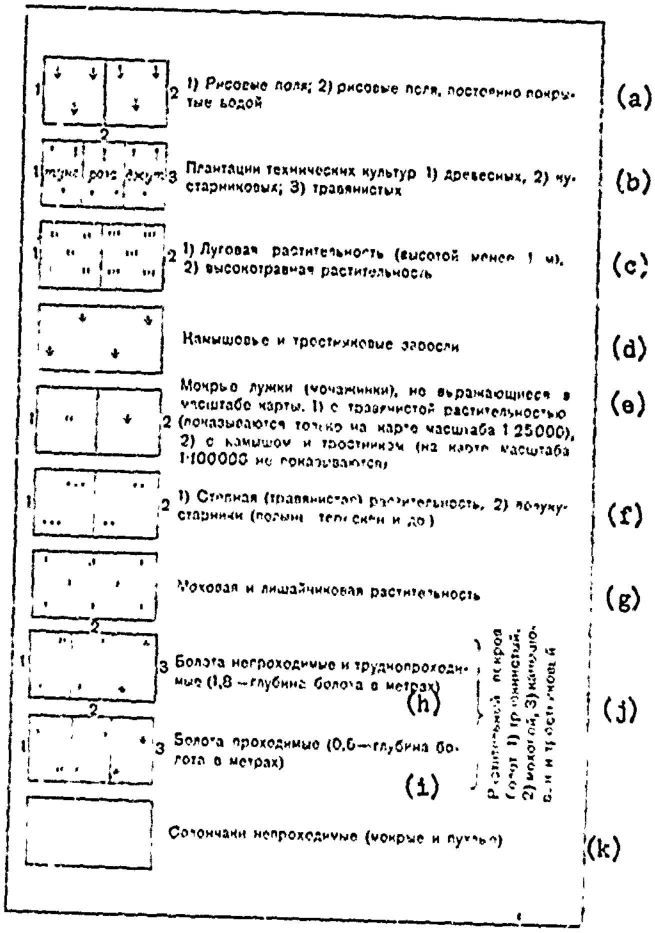
Key: a - mixed forests (spruce and birsh shown); b - characteristics of stand of timber in meters: in numerator - height of trees, in denominator - thickness, to the right of the fraction - distance between trees; c - narrow strips of forest and protective tree plantings(2 - average height of trees in meters); d - small forest areas not expressed at map scale; e - individual woods not expressed at map scale: 1) coniferous, 2) deciduous, 3) mixed; f - trees standing alone and having significance as reference points: 1) coniferous, 2) deciduous; g - lone trees having no significance as reference points; h - 1) palm groves expressed at map scale, 2) palm groves not expressed at map scale, 2) lone palms; i - scrub growth (dwarf) forests; j - forest undergrowth, forest nurseries and young forest plantings up to 4 meters high (2 - average height of trees in meters).



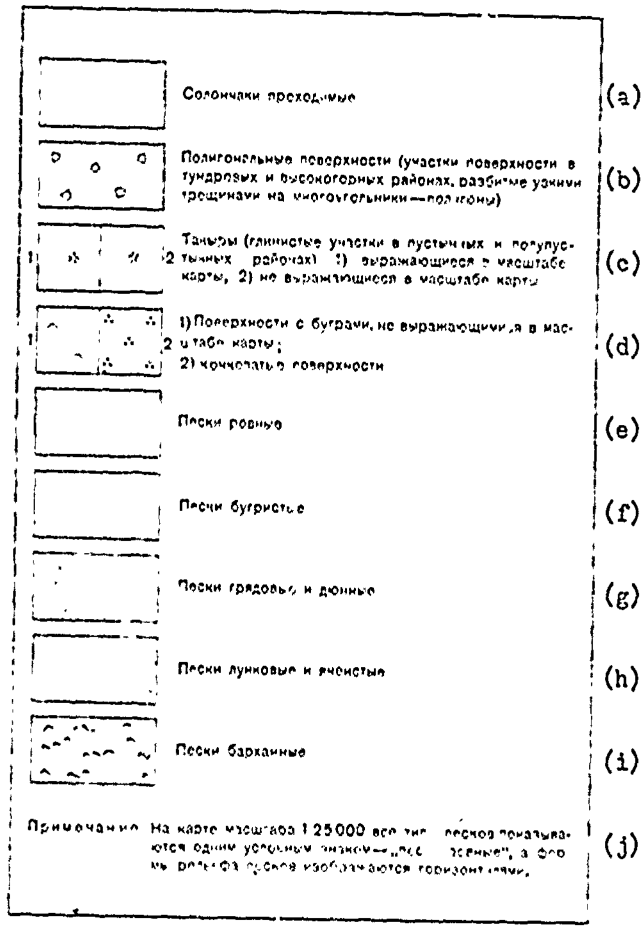
Key: a - blowdown; b - 1) sparse woods (thin forest), 2) sparse scrub forest; c - 1) burnt and dry forests, 2) felled forests; d - clearings in a forest with width: 20 meters or more - on 1:25,000 map, 40 meters or more - on 1:50,000 map, 60 meters or more - on 1:100,000 map; electric transmission lines along clearings; e - other clearings in forest (4 - width of clearing in meters), 22, 23 - number of forest blocks; f - forest roads along clearings; g - communications lines along clearings (5 - width of clearing in meters); h - boundaries along clearings; i - brush: 1) lone bushes and groups of bushes, 2) continuous overgrowth; j - species of brush: 1) coniferous, 2) deciduous (0.8 - average height of brush in meters).



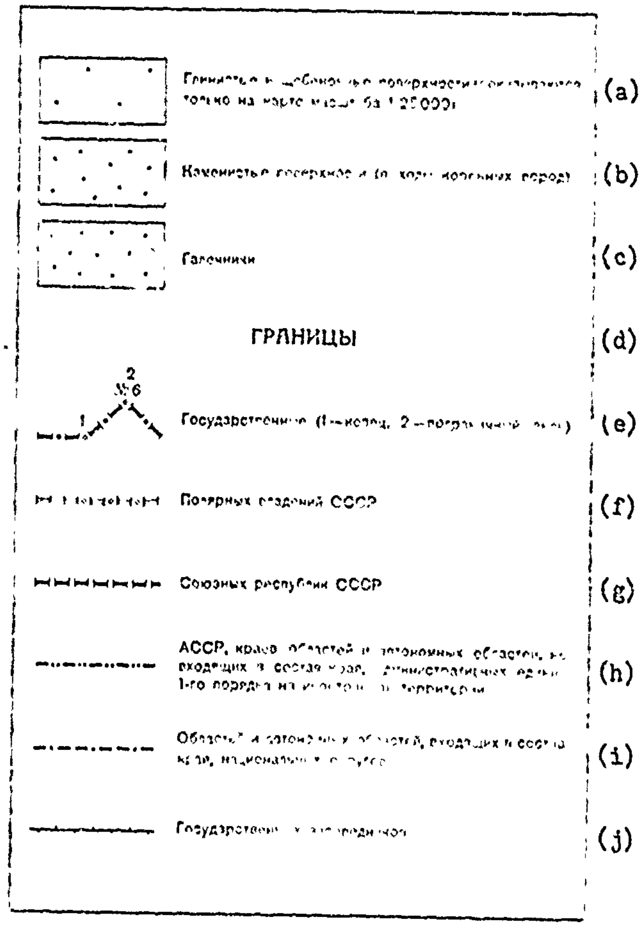
Key: a - narrow strips of brush and living fences; b - thorny brush (continuous overgrowth); c - haloxylon: 1) lone groups, 2) continuous overgrowth; d - creeping bushes: 1) lone groups, 2) continuous overgrowth; e - bamboo overgrowth; f - fruit and citrus gardens; g - vineyards; h - berry gardens (currant, raspberry and other berry bushes); i - mangrove overgrowth (special type of tropical vegetation of inundated coasts); j - hotbeds (shown only on 1:25,000 maps).



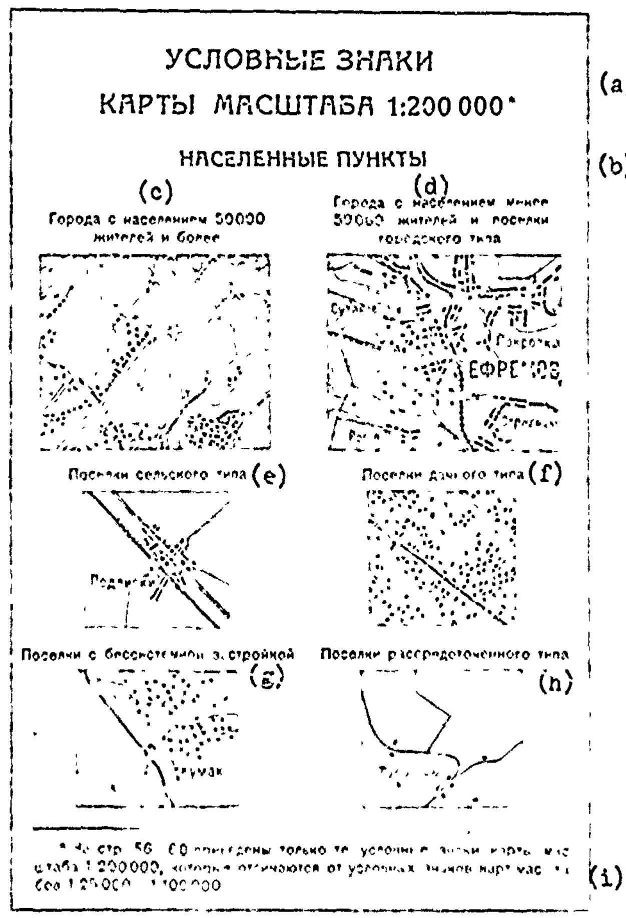
Key: a - 1) rice fields, 2) rice fields permanently covered with water; b - plantations of technical crops: 1) woody (tung shown), 2) bushes (rose shown), 3) grassy (jute shown); c - 1) meadow vegetation (height less than 1 meter), 2) high grassy cover; d - reed and cane overgrowth; e - wet small meadows (land permanently wet from outflow of underground water),not expressed at map scale: 1) with grassy vegetation shown only on 1:25,000 maps, 2) with reed and cane (not shown on 1:100,000 map); f - 1) steppe (grassy vegetation, 2) undershrub (wormwood,winterfat, and others); g - moss and lichen vegotation; h - impassable swamps and s' amps difficult to negotiate (1.8 - depth of swamp in meters); i - passable swamps (0.6 - depth of swamp in meters); j - vegetational cover of swamps: 1) grassy, 2) mossy, 3) reed and cane; k - impassable salt marches (wet and swollen).



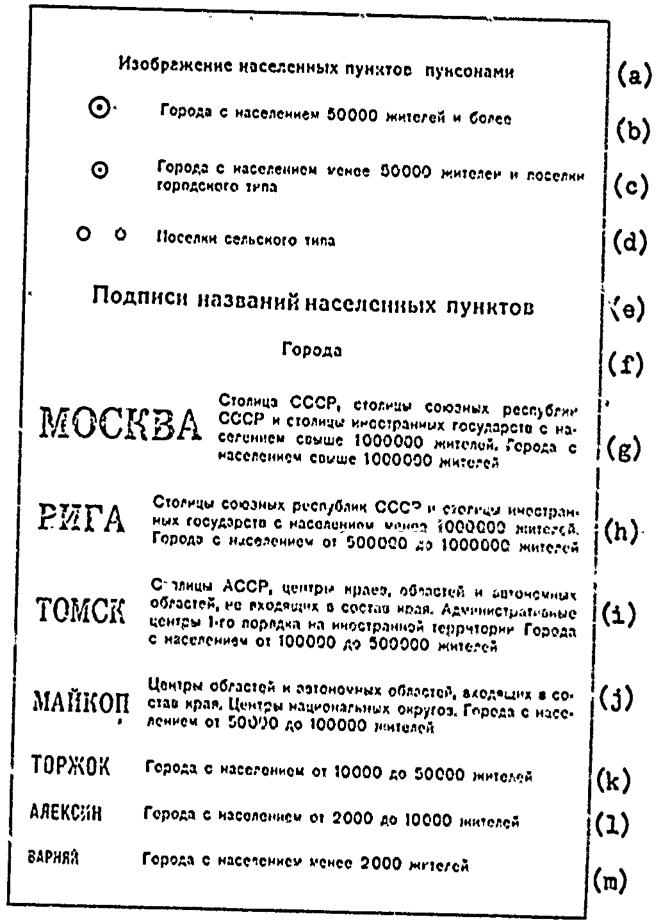
Key: a - passable salt marches; b - polygonal surfaces (sectors of surface in tundra and high-mountain areas divided into polygons by narrow cracks); c - takyr soil (clayey sectors in desert and semidesert regions): 1) expressed at map scale, 2) not expressed at map scale; d - 1) surfaces with hillocks not expressed at map scale, 2) hillock surfaces; e - flat sands; f - hillock sands; g - ridged and dune sands; h - alveolar and cellular sands; i - barkhan sands; j - Remarks: On 1:25,000 maps, all types of sand are shown with one conventional symbol - "flat sands" - and the relief form of the sands are shown by contour lines.



Key: a - clayey and gravelly surfaces (shown only on 1:25,000 maps); b - stony surfaces (rock outcrops); c - pebble; d - boundaries; e - national (1 - cadastral marker, 2 - border marker); f - arctic possessions of the USSR; g - union republics of the USSR; h - ASSR's, krays, oblasts, and autonomous oblasts not part of a kray, 1st category administrative units on foreign territory; i - oblasts and autonomous oblasts part of a kray or national okrugs; j - state forest reservations.



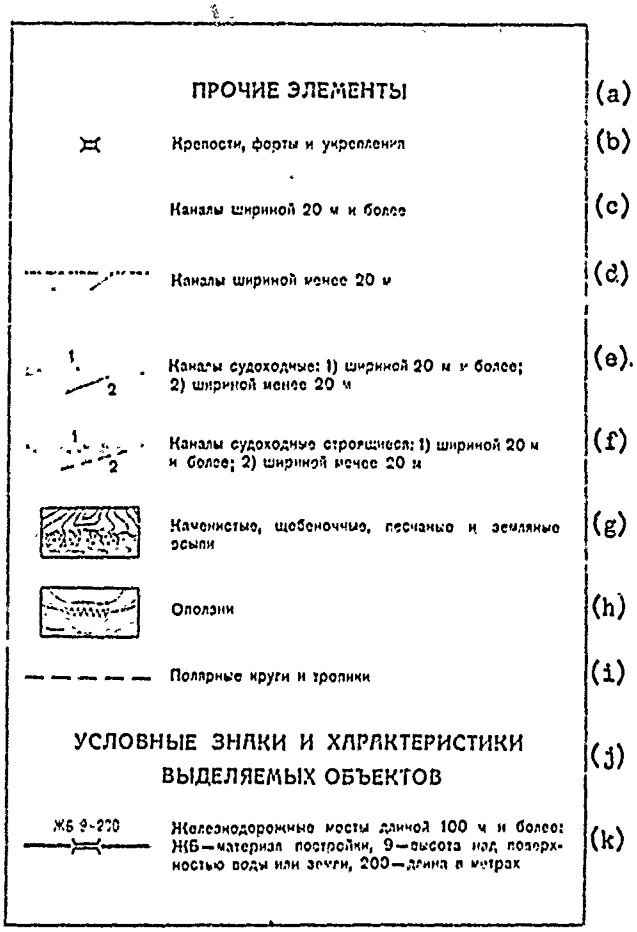
Key: a - Symbols for 1:200,000 maps*; b - Populated places; c - cities with a population of 50,000 inhabitants or more; d - cities with a population of less than 50,000 inhabitants and city-type settlements; e - rural-type settlements; f - suburban-type settlement; g - settlements with random structures; h - dispersed-type settlements; i - *Pages 284-288 [pp. 56-60 of original text] present only those symbols for a 1:200,000 map which differ from map symbols of 1:25,000 to 1:100,000 maps.



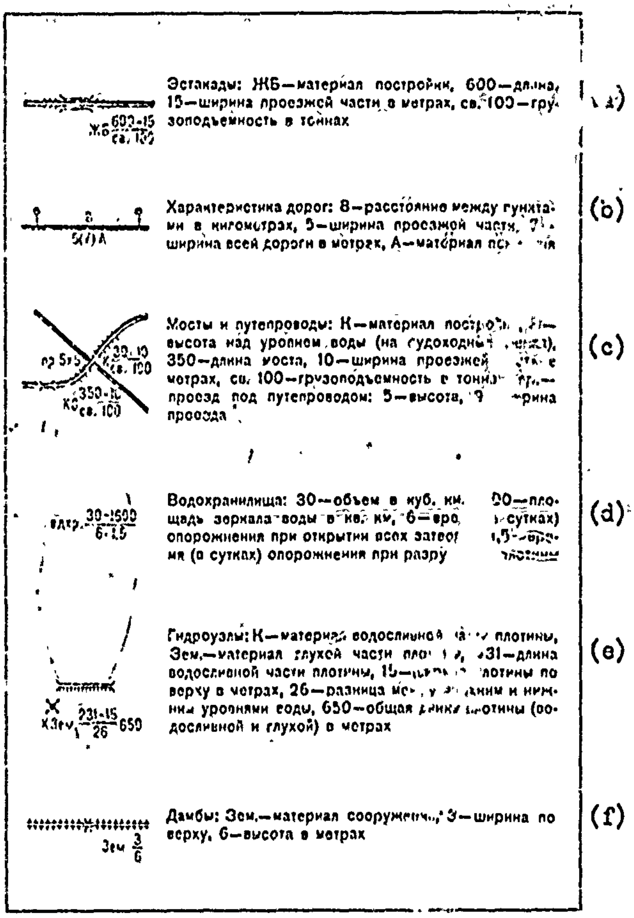
Key: a - representing populated places with points; b - cities with a population of 50,000 inhabitants or more; c - cities with a population of less than 50,000 inhabitants and city-type settlements; d - rural-type settlements; e - labels of names of populated places; f - cities; g - Moscow - Capital of the USSR, capitals of union republics of the USSR and capitals of foreign countries with a population of more than 1,000,000 inhabitants. Cities with a population greater than 1,000,000; h - .iga - capitals of union republics of the USSR and capitals of foreign states with a population of less than 1,000,000 inhabitants. Cities with a population of from 500,000 to 1,000,000; i - Tomsk - capitals of ASSR's, centers of krays, oblasts, and autonomous oblasts not part of a kray. 1st category administrative centers on foreign territory. Cities with a population of from 100,000 to 500,000; j - Maykop - centers of oblasts and autonomous oblasts which are part of a kray. Centers of national okrugs. Cities with a population of from 50,000 to 100,000 inhabitants; k - Torzhok - cities with a population of from 10,000 to 50,000 inhabitants; l - Aleksin - cities with a population of from 2,000 to 10,000 inhabitants; m - Varnay - cities with a population of less than 2,000 inhabitants.

Поселки городского типа (рабочие, курортные и пр.)		(a)
КОДЖОРИ	2000 жителей и более	(b)
ДУБКИ	менее 2000 жителей	(c)
Поселки при промышленных предприятиях, железнодорожных станциях, пристанях и т.п.		(d)
Октябрьский	1000 жителей и более	(e)
Рудничный	менее 1000 жителей	(f)
Поселки сельского и дачного типа		(g)
Павловка	более 1000 жителей (более 200 домов)	(h)
Подлипки	от 500 до 1000 жителей (от 100 до 200 домов)	(i)
Томохово	от 100 до 500 жителей (от 20 до 100 домов)	(j)
Турицыно	менее 100 жителей (менее 20 домов)	(k)
Динский	Отдельные дворы	(l)
Железнодорожные станции		(m)
Горбачево	Узловые и большие станции	(n)
Навтлуг	Станции, разъезды, платформы и остановочные пункты	(o)
Примечание.	Если на карте название населенного пункта подчеркнуто, то оно относится и к ближайшей железнодорожной станции или речной пристани.	(p)

Key: a - city-type settlements (workers', health resorts, etc.); b - Kodzhori - 2,000 or more residents; c - Dubki - less than 2,000 inhabitants; d - settlements with industrial enterprises, railroad stations, landings, etc.; e - Oktyabr'skiy - 1,000 or more inhabitants; f - Rudnichnyy - less than 1,000 inhabitants; g - rural and suburban-type settlements; h - Pavlovka - more than 1,000 inhabitants (more than 200 houses); i - Podlipki - from 500 to 1,000 inhabitants (from 100 to 200 houses); j - Tomokhovo - from 100 to 500 inhabitants (from 20 to 100 houses); k - Turitsyno - less than 100 inhabitants (less than 20 houses); l - Dinskiy - lone courtyards; m - railroad stations; n - Gorbachevo - junctions and large stations; o - Navtlug - stations, sidings, platforms, and stopping points; p - Remarks: If the name of a populated place is underlined on a map, it pertains to the closest railroad station or river landing.



Key: a - Other elements; b - fortresses, forts, and fortifications; c - canals 20 meters wide or more; d - canals less than 20 m wide; e - navigable canals: 1) 20 meters or more wide, 2) less than 20 m wide; f - navigable canals under construction: 1) 20 meters wide or more, 2) less than 20 meters wide; g - rock, gravel, sand, and dirt talus; h - earth creeps; i - arctic and tropic circles; j - Symbols and characteristics of objects which are distinguished; k - railroad bridges 100 meters long or more: ZhB - structural material (ferroconcrete), 9 - height above the surface of the water or the ground, 200 - length in meters.

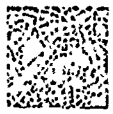


Key: a - trestles: ZhB - construction material, 600 - length, 15 - width of roadway in meters, CB.100 - load capacity in tons (CB = above); b - road characteristics: 8 - distance between points, in kilometers, 5 - width of roadway, 7 - width of entire road in meters, A - surfacing material; c - bridges and viaducts: K - construction material, 8 - height above water level (on navigable rivers), 350 - length of bridge, 10 - width of roadway in meters, CB.100 - load capacity in tons, np - passage beneath viaduct: 5 - height, 9 - width of passage; d - reservoirs: 30 - volume in cubic kilometers, 1500 - area of water surface in square kilometers, 6 - time (in days) for emptying with all floodgates open, 1.5 - time in days for emptying with destruction of dam, zem. - material of blind part of dam, 231 - length of spillway part of dam, 15 - width of dam along the top in meters, 26 - difference between upper and lower water levels, 650 - overall length of dam (spillway and blind) in meters; f - dams: zem- material of structure, 3 - width along the top, 6 - height in meters.

УСЛОВНЫЕ ЗНАКИ КАРТЫ (a)

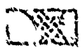
МАСШТАБА 1:500 000*

НАСЕЛЕННЫЕ ПУНКТЫ (b)

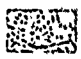


Города с населением 50000 жителей и более и крупные железнодорожные узлы (c)

Города с населением менее 50000 жителей и поселки городского типа (d)



Поселки сельского типа (e)



Поселки дачного типа (f)

Поселки с бессистемной застройкой (g)

Поселки рассредоточенного типа (h)

* На стр. 61–65 приведены только те условные знаки карты масштаба 1:500000, которые отличаются от условных знаков карт масштабов 1:25 000–1:200 000. (i)

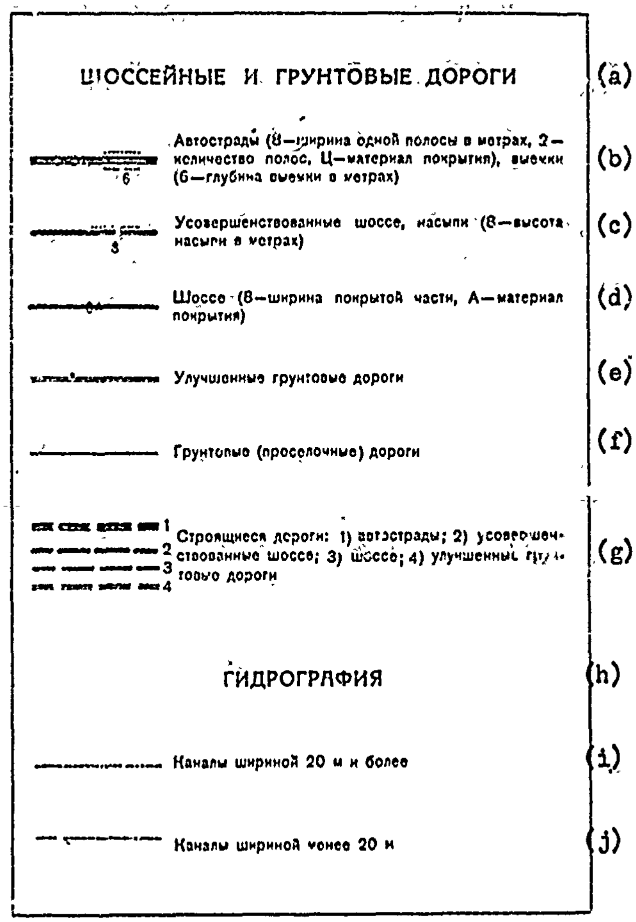
Key: a - Symbols for a 1:500,000 map*; b - populated places; c - cities with a population of 50,000 residents or more and large railroad centers; d - cities with a population of less than 50,000 inhabitants and city-type settlements; e - rural-type settlements; f - suburban-type settlements; g - dispersed-type settlements; i - *Pages 289-293 [pp. 61-65 in original text] present only those symbols for a 1:500,000 map which differ from the symbols of 1:25,000 to 1:200,000 maps.

Подписи названий населенных пунктов		(a)
Города		(b)
МОСКВА	Столица СССР, столицы союзных республик СССР и столицы иностранных государств с населением свыше 1000000 жителей. Города с населением свыше 1000000 жителей	(c)
РИГА	Столицы союзных республик СССР и столицы иностранных государств с населением менее 1000000 жителей. Города с населением от 500000 до 1000000 жителей	(d)
ТОМСК	Столицы АССР, центры краев, областей и автономных областей, не входящих в состав края. Административные центры 1-го порядка на иностранной территории. Города с населением от 100000 до 500000 жителей	(e)
МАЙКОП	Центры областей и автономных областей, входящих в состав края. Центры национальных округов. Города с населением от 50000 до 100000 жителей	(f)
ТОРЖОК	Города с населением от 10000 до 50000 жителей	(g)
АЛЕКСИН	Города с населением от 2000 до 10000 жителей	(h)
ВАРНЯЙ	Города с населением менее 2000 жителей	(i)

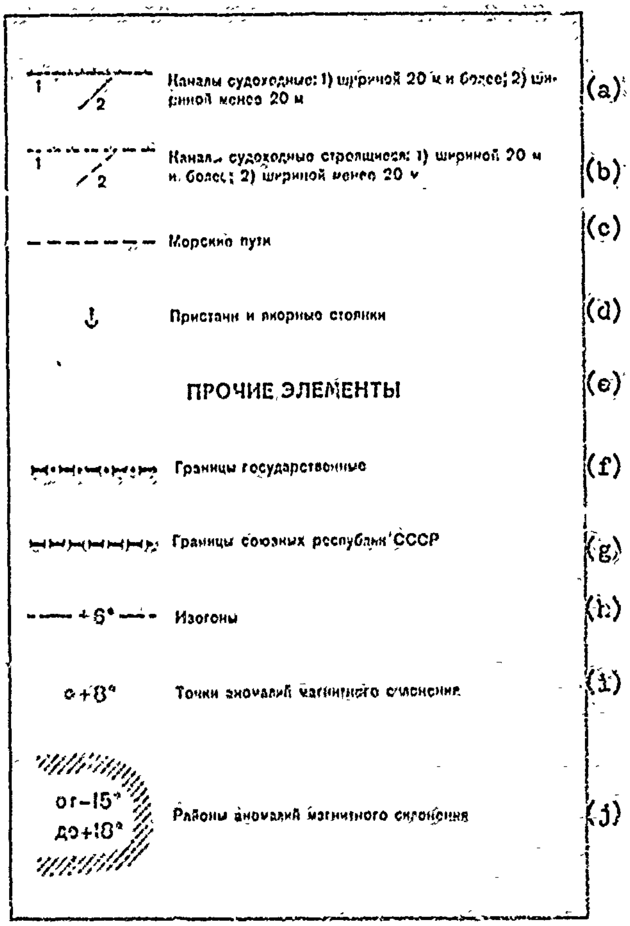
Key: a - Labels of names of populated places; b - cities; c - Moscow - capital of the USSR, capitals of union republics of the USSR, and capitals of foreign countries with a population of over 1,000,000 inhabitants. Cities with a population of over 1,000,000 inhabitants; d - Riga - capitals of union republics of the USSR and capitals of foreign countries with a population of less than 1,000,000 inhabitants. Cities with a population of from 500,000 to 1,000,000 inhabitants; e - Toms - capitals of ASSR's, centers of krays, oblasts, and autonomous oblasts which are not part of a kray. 1st category administrative centers on foreign territory. Cities with a population of from 100,000 to 500,000 residents; f - Maykop - centers of oblasts and autonomous oblasts part of a kray. Centers of national okrugs. Cities with a population of from 50,000 to 100,000 inhabitants; g - Torzhok - cities with a population of from 10,000 to 50,000 inhabitants; h - Aleksin - cities with a population of from 2,000 to 10,000 residents; i - Varnay - cities with a population of less than 2,000 inhabitants.

Поселки городского типа (рабочие, курортные и пр.)		(a)
КОДЖОРИ	2000 жителей и более	(b)
ДУБКИ	менее 2000 жителей	(c)
Поселки сельского и дачного типа		(d)
Вербилово Вербилово Вербилово	более 1000 жителей	(e)
Вишенка Вишенка Вишенка	от 500 до 1000 жителей	(f)
Беловка *Беловка* *Беловка*	менее 500 жителей	(g)
Железнодорожные станции		(h)
Горбачево	Узловые и большие станции	(i)
Навтлуг	Станции, разъезды, платформы и остановочные пункты	(j)
Примечание. Если на карте название населенного пункта подчеркнуто, то оно относится и к ближайшей железнодорожной станции или речной пристани.		(k)

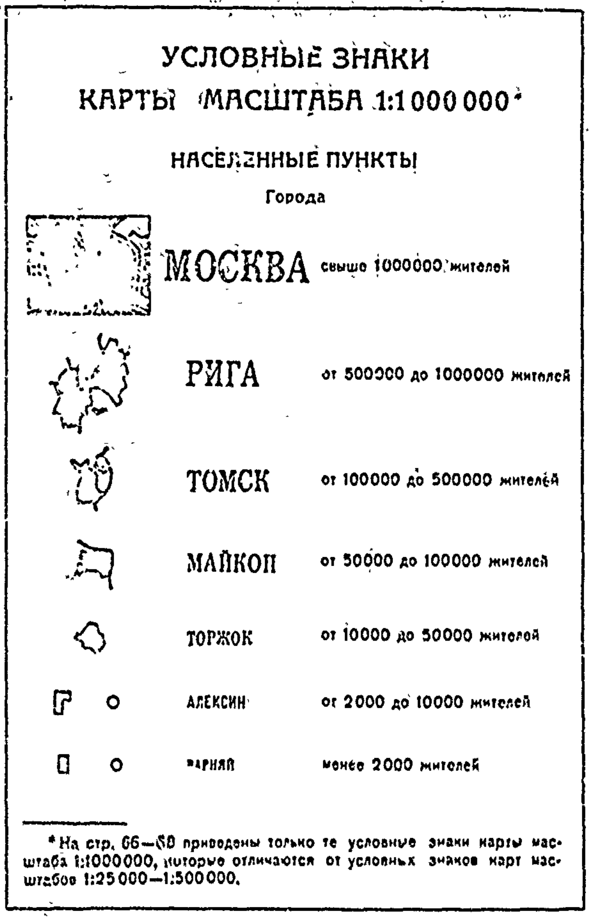
Key: a - city-type settlements (workers', health resorts, etc.); b - Kodzhori - 2,000 or more inhabitants; c - Dubki - less than 2,000 inhabitants; d - settlements of the rural and suburban type; e - Verbilovo - more than 1,000 inhabitants; f - Vishenka - 500 to 1000 inhabitants; g - Belovka - less than 500 inhabitants; h - railroad stations; i - Gorbachevo - junctions and large stations; j - Navtlug - stations, sidings, platforms, and stopping points; k - Remarks: If the name of a populated place is underlined on a map, it also pertains to the nearest railroad station or river landing.



Key: a - Highways and dirt roads; b - superhighways (8 - width of lane in meters, 2 - number of lanes, Ts - surface material), depressions (6 - depth of depression in meters); c - improved highways, embankments (8 - height of embankment in meters); d - highways (8 - width of surfaced part, A - surface material); e - improved dirt roads; f dirt (country) roads; g - roads under construction: 1 - superhighways, 2) improved highways, 3) highway, 4) improved dirt roads; h - Hydrography; i - canals 20 meters wide or more; j - canals less than 20 meters wide.

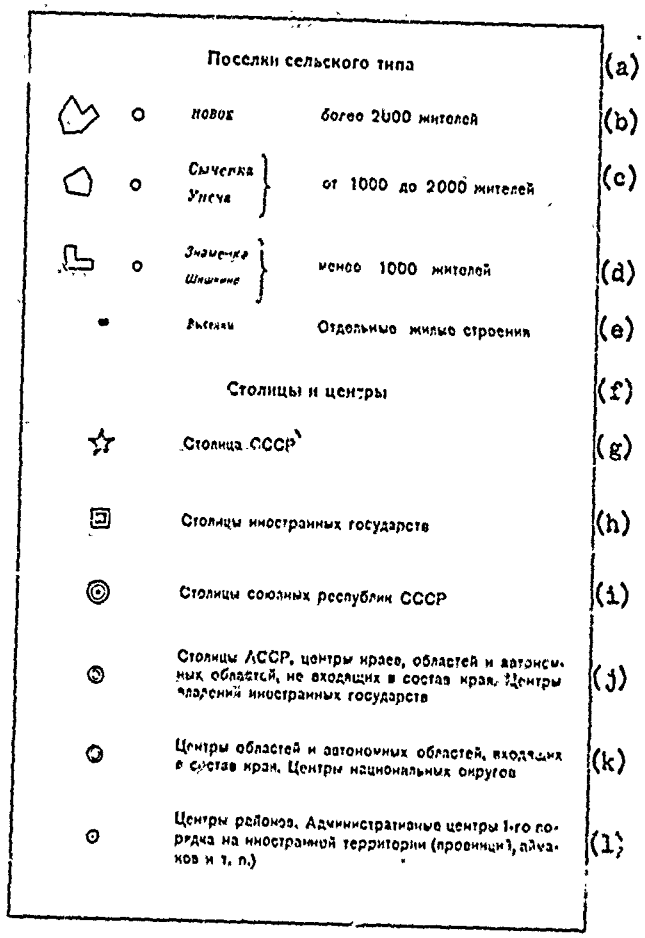


Key: a - navigable canals: 1) 20 meters wide or more, 2) less than 20 meters wide; b - navigable canals under construction: 1) 20 meters wide or more, 2) less than 20 meters wide; c - sea routes; d - landings and anchorages; e - Other elements; f - national boundaries; g - boundaries of union republics of the USSR; h - isogons; i - points of magnetic declination anomalies; j - areas of magnetic declination anomalies.

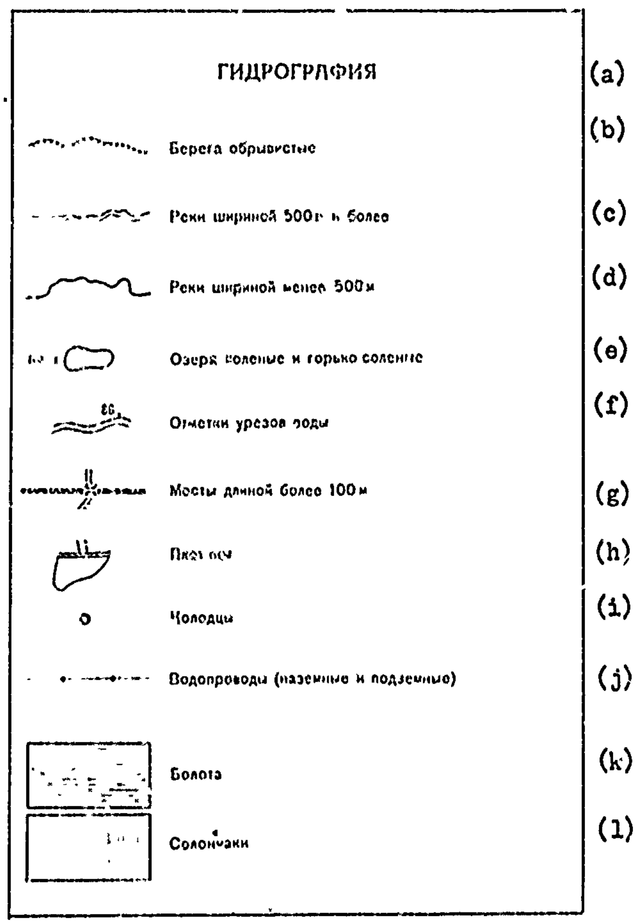


(a) (b) (c) (d) (e) (f) (g) (h) (i) (j) (k)

Key: a - Symbols for 1:1,000,000 maps*; b - populated places; c - cities; d - Moscow - over 1,000,000 inhabitants; e - Riga - from 500,000 to 1,000,000 inhabitants; f - Tomsk - from 100,000 to 500,000 inhabitants; g - Maykop - from 50,000 to 100,000 inhabitants; h - Torzhok - from 10,000 to 50,000 inhabitants; i - Aleksin - from 2,000 to 10,000 inhabitants; j - Varnay - less than 2,000 inhabitants; k - *Pages 294-296 [pp. 66-68 in original text] present only those symbols for a 1:1,000,000 map which differ from symbols for 1:25,000 to 1:500,000 maps.



Key: a - Rural-type settlements; b - Novoye - more than 2,000 inhabitants; c - Sychevka/Unecha - from 1,000 to 2,000 inhabitants; d - Znamenka/Shishkina - less than 1000 inhabitants; e - Vyselki - separate residential structures; f - capitals and centers; g - capital of the USSR; h - capitals of foreign states; i - capitals of union republics of the USSR; j - capitals of ASSR's, centers of krays, oblasts, and autonomous oblasts not part of a kray. Centers of possessions of foreign states; k - centers of oblasts and autonomous oblasts part of a kray. Centers of national okrugs; l - centers of rayons. 1st category administrative centers on foreign territory (provinces, aymaks, etc.).



<u>Key</u>: a - Hydrography; b - precipitous shores; c - rivers, 500 meters wide or more; d - rivers less than 500 meters wide; e - salt lakes and bitter-salty lakes; f - altitude readings of water's edge; g - bridges more than 100 meters long; h - dams; i - wells; j - water pipes (on and under the ground); k - swamps; l - salt marshes.

LIST OF CONVENTIONAL ABBREVIATIONS USED ON TOPOGRAPHIC MAPS

А

А	A	asphalt, asphalt-concrete (road surfacing material)
авт.	avt.	automobile plant
алб.	alb.	alabaster plant
анг.	ang.	hangar, shed
анил.	anil.	aniline dye plant
АО	AO	Autonomous Oblast
апат.	apat.	apatite works
ар.	ar.	irrigation ditch (canal or ditch in Central Asia)
арт.к.	art.k.	artesian well
арх.	arkh.	archipelago
асб.	asb.	asbestos plant, quarry, mine
АССР	ASSR	Autonomous Soviet Socialist Republic
астр.	astr.	astronomic station
асф.	asf.	asphalt plant
аэрд.	aerd.	airfield
аэрп.	aepr	airport

Б

Б	B	cobblestones (road surfacing material)
б. бал.	b. bal.	ravine
Б. Бол.	B. Bol.	Big (part of a proper name)
бар.	bar.	barrack
бас.	bas.	basin
бер.	ber.	birch (tree species)
Бет.	Bet.	concrete (dam material)
биол.ст.	biol.st.	biological station
бл.-п.	bl.-p.	blockhouse (railroad)
бол.	bol.	swamp
Бр	Br.	block (road surfacing material)
бр.	br.	ford
бр.мог.	br. mog.	common grave
б.тр.	b. tr.	transformer vault
булг.	bulg.	hydrolaccoliths (a separate, naturally formed protuberance)
бум.	bum.	paper industry (mill, combine)
бур.	bur.	drilling tower, drill hole
бух.	bukh.	bay

В

В	V	viscous (ground on river bottom)
ваг.	vag.	railroad car repair, railroad car construction plant
вдкч.	vdkch.	pumping station, water supply station
вдп.	vdp.	waterfall
вдпр.ст.	vdpr.st.	water works
вдхр.	vdkhr.	reservoir
Вел.	Vel.	Great (part of proper name)
вет.	vet.	veterinary point
вин.	vin.	winery, distillery
вкз.	vkz.	station
влк.	vlk.	volcano
вод.	vod.	water tower
Выс.	Vys.	Settlement (part of proper name)

Г

Г	G	gravel (road surfacing material)
гав.	gav.	harbor
газ.	gaz.	gas works, gas tower, gas drill hole
газг.	gazg.	gas tank
гал.	gal.	haberdashery industry (plant, factory)
галеч.	galech.	bench gravel (extraction product)
гар.	gar.	garage
гидрол.ст.	hidrol. st.	hydrological station
Гл.	Gl.	Main (part of proper name)
глин.	glin.	clay (extraction product)
глиноз.	glinoz.	aluminum plant
гонч.	gonch.	pottery plant
гор.	gor.	hot spring
гост.	gost.	hotel
г.прох.	g. prokh.	mountain pass
гряз.	gryaz.	mud volcano
ГСМ	GSM	fuels and lubricants (warehouse, dump)
г.-сол.	g.-sol.	bitter-salty water (in lakes, springs, wells)
гсп.	gsp.	hospital
ГЭС	GES	hydroelectric station

Д

Д	D	wooden (material of a bridge, dam)
дв.	dv.	yard
дет.д.	det.d.	children's home

джут.	dzhut.	jute mill
Д.О.	D.O.	rest home
домостр.	domostr.	house-building plant, combine
древ.	drev.	woodworking industry (plant, mill)
древ.уг.	drev. ug.	charcoal (kilning product)
дров.	drov.	firewood storage
дрож.	drozh.	yeast plant

Е

ер.	yer.	yerik (narrow, deep channel connecting the channel of a river with a small lake)

Ж

ЖБ	ZhB	ferroconcrete (material for a bridge, dam)
жел.	zhel.	source of iron, place for mining iron ore, iron dressing plant
жел.-кисл.	zhel.-kisl.	source of ferric acid

З

Зап.	Zap.	Western (part of proper name)
зап.	zap.	log trestles (settling basin, inlet)
запов.	zapov.	national forest
засып.	zasyp.	filled-in well
зат.	zat.	cove (inlet on a river used for wintering and repairing vessels)
звер.	zver.	fur-breeding sovkhoz, nursery
Зем.	Zem.	dirt (material of a dam)
земл.	zeml.	mud hut
зерк.	zerk.	mirror plant
зерн.	zern.	grain sovkhoz
зим.	zim.	wintering place, winter hut
зол.	zol.	gold (placer mine, deposit)
зол.-плат.	zol.-plat	gold-platinum works

И

игр.	igr.	toy factory
изв.	izv.	lime quarry, lime (product of calcination)
изумр.	izumr.	emerald mine
инст.	inst.	institute
иск.волок.	isk. volok.	artificial fiber (mill)
ист.	ist.	spring

K

К	K	rocky (soil on river bottom), crushed stone (material for surfacing a road), stony (bridge and dam material)
К., к.	K., k.	well
каз.	kaz.	barracks
кам.	kam.	stone quarry, stone
кам.-дроб.	kam.-drob.	stone-crushing works
кам.стб.	kam.stb.	stone column
кам.уг.	kam.ug.	bituminous coal (mining product)
кан.	kan.	canal
канат.	kanat.	cable or rope plant
каол.	kaol.	kaolin (extraction product) kaolin enriching plant
каракул.	karakul.	karakul-raising sovkhoz
карант.	karant.	quarantine
кауч.	kauch.	rubber plant, rubber planatation
керам.	keram.	ceramic plant
кин.	kin.	cinematography industry (factory, plant)
кирп.	kirp.	brick works
Кл	Kl	clinker (material for surfacing roads)
клх.	klkh.	kolkhoz [collective farm]
кож.	kozh.	tannery
кокс.	koks.	coal-tar chemical plant
комбик.	kombik.	combined fodder plant
компрес.ст.	kompres.st.	compressor station
кон.	kon.	horse-breeding sovkhoz, stud farm
конд.	kond.	confectionary plant
коноплл.	konopl.	hemp-raising sovkhoz
конс.	kons.	cannery
котл.	kotl.	hollow
коч.	koch.	nomad camp
кош	kosh.	sheep pen
Кр.	Kr.	Red, Beautiful (part of proper name)
Красн.	Krasn.	
креп.	krep.	fortress
круп.	krup.	groats mill, hulling mill
кум.	kum.	heathenish temple
кур.	kur.	health resort

Л

Лаг.	lag.	lagoon
лакокр.	lakokr.	paint and varnish plant
Лев.	Lev.	Left (part of proper name)
лесн.	lesn.	forester'r house
леснич.	lesnich.	forestry
лесп.	lesp.	sawmill
лет.	let.	annual, summer quarters
леч.	lech.	hospital, nursing home
ЛЗС	LZS	forest protection station
лим.	lim.	estuary
листв.	listv.	deciduous (species of tree)
льнообр.	l'noobr.	flax processing plant

М

М	M	metal (bridge material)
м.	m.	cape
мак.	mak.	macaroni plant
М. Мал.	M.) Mal.)	Small (part of proper name)
маргар.	margar.	margarine plant
маслоб.	maslob.	oil press plant
маслод.	maslod.	creamery
маш.	mash.	machine-building plant
меб.	meb.	furniture plant
медепл.	medepl.	copper works, combine
медн.	medn.	copper mining
мет.	met.	metallurgical plant, plant for metal articles
мет.-обр.	met.-obr.	metal-working plant
мет.ст.	met.st.	meteorological station
мех.	mekh.	fur plant
МЖС	MZhS	machinery and animal breeding station
мин.	min.	mineral spring
ММС	MMS	machinery and reclamation station
мог.	mog.	grave, graves
мол.	mol.	dairy plant
мол.-мясн.	mol.-myasn.	dairy - meat sovkhoz
мон.	mon.	monastery
мрам.	mram.	marble (extraction product)
МТМ	MTM	machinery-tractor shop
МТФ	MTF	milk products farm

муз.инстр.	muz.instr.	musical instruments (plant)
мук.	muk.	flour mill
мыл.	myl.	soap works

Н

набл.	nabl.	observation tower
наполн.	napoln.	filling capacity of well
нац.окр.	nats. okr.	national okrug [region]
недейств.	nedeystv.	inoperative
нефт.	neft.	petroleum output, petroleum refinery, oil tank, oil tower
Ниж.	Nizh.	Lower (part of proper name)
ник	nik.	nickel (mining product)
Нов.	Nov.	New (part of proper name)

О

о. о-ва	o. o-va	island, islands
оаз.	oaz	oasis
обсерв.	observ.	observatory
овр.	ovr.	gully
овц.	ovts.	sheep sovkhoz
огнеуп.	ogneup.	fire resistant articles (plant)
оз.	oz.	lake
Окт.	Okt.	October (part of proper name)
ор.	or.	greenhouse
ост.п.	ost.p.	stopping point (railroad)
отд.свх.	otd.svkh.	sovkhoz section
ОТФ	OTF	sheep products farm
охотн.	okhotn.	hunting cottage

П

П	p	sandy (bottom soil of river), plowed field
п. пос.	p. pos.	settlement
пам.	pam.	monument
пар.	par.	ferry
парф.	parf.	perfumery-cosmetic plant
пас.	pas.	apiary
пер.	per.	pass (mountain), transport
пес.	pes.	sand (extraction product)
пещ.	peshch.	cave

пив.	piv.	brewery
питт.	pit.	nursery
пищ.конц.	pishch.konts.	food concentrates (plant)
пл.	pl.	flatcar (railroad)
пластм.	plastm.	plastics (plant)
плат.	plat.	platinum (mining product)
плем.	plem.	pedigree cattle-breeding sovkhoz
плодовин.	plodovin.	fruit grape sovkhoz
плодоовощ.	plodoovoshch.	fruit and vegetable sovkhoz
плод.-яг.	plod.-yag.	fruit and berry sovkhoz
п-ов	p-ov	peninsula
погр.заст.	pogr.zast.	border detachment
погр.кмд.	pogr.kmd.	border commandant's office
погруз.	pogruz.	loading-unloading area
пож.	pozh.	fire tower (depot, shed)
полигр.	poligr.	printing and publishing industry (combine, plant)
пол.ст.	pol.st.	field camp
пор.	por.	threshold, rapids
пос.пл.	pos.pl.	landing field
пост.дв.	post.dv.	inn
пр.	pr.	pond, strait, thoroughfare (beneath a viaduct)
Прав.	Prav.	Right (part of proper name)
прист.	prist.	wharf
пров.	prov.	province
провол.	provol.	wire plant
прот.	prot.	channel
пряд.	pryad.	spinning plant
ПС	PS	settlement Soviet
ПТФ	PTF	poultry farm
пут.п.	put.p.	track post

Р

рад.	rad.	radio plant
радиост.	radiost.	radio station
раз.	raz.	siding
разв.	razv.	ruins
разр.	razr.	destroyed
рез.	rez.	rubber products (plant, factory)
рис.	ris.	rice mill
р.п.	r.p.	workers' settlement
РС	RS	Rayon [regional] Soviet
руд.	rud.	mine

рук.	ruk.	hose
рыб.	ryb.	fishery (plant, factory)
рыб.пос.	ryb.pos.	fishing village

С

сан.	san.	sanatorium
сар.	sar.	barn
сах.	sakh.	sugar mill
сах.трост.	sakh.trost.	sugar cane
СВ	SV	Northeast
Св.	Sv.	Saint (part of proper name)
св.	sv.	over
свекл.	svekl.	sugar beet sovkhoz
свин.	svin.	pig-breeding sovkhoz
свинц.	svints.	lead mine
свх.	svkh.	sovkhoz [state farm]
Сев.	Sev.	North (part of proper name)
сел.ст.	sel.st.	selection station
семен.	semen.	seed-growing farm
серн.	sern.	sulfur spring, sulfur mine
СЗ	SZ	Northwest
сил.	sil.	silo
силик.	silik.	silicate industry (plant, factory)
ск.	sk.	cliff, sliffs
скип.	skip.	turpentine plant
скл.	skl.	storehouse
сланц.	slants.	shale works
смол.	smol.	tar distillery
Сов.	Sov.	Soviet (part of proper name)
соев.	soyev.	soybean sovkhoz
сол.	sol.	salty water, salt works, salt mining
соп.	sop.	coniform peak
сорт.ст.	sort.st.	sorting station
спас.ст.	spas.st.	rescue station
спич.	spich.	match factory
Ср.	Sr.	Middle (part of proper name)
Сред.	Sred.	Middle (part of proper name)
СС	SS	village Soviet
Ст.	St.	Old (part of proper name)
Стар.	Star.	Old (part of proper name)
стад.	stad.	stadium
стал.	stal.	steel mill

стан.	stan.	camp, nomad camp
стб.	stb.	column
стекл.	stekl.	glass works
ст.перекач.	st. perekach	pumping station
стр.	str.	under construction
стр.м.	str.m.	construction materials plant
СТФ	STF	swine products farm
суд.	sud.	ship repair, shipyard
сук.	suk.	cloth factory
сух.	sukh.	dry well
суш.	sush.	dryer
с.-х.	s.-kh.	agricultural
с.-х.маш.	s.-kh.mash.	agricultural machinery-building (plant)

Т

Т	T	herd (soil on river bottom)
таб.	tab.	tobacco-growing sovkhoz, tobacco factory
там.	tam.	customs house
текст.	tekst.	textile industry (combine, factory)
тер.	ter.	waste pile (dump of waste rock at a mine shaft)
техн.	tekhn.	technical institute
тов.ст.	tov.st.	commodity station
тол.	tol.	roofing plant
торф.	torf.	peat works
тракт.	trakt.	tractor plant
трик.	trik.	knitting factory
тун.	tun.	tunnel
ТЭЦ	TETs	heat and electric power station

У

уг.	ug.	brown coal, bituminous coal (mining product)
уг.-кисл.	ug.-kisl.	carbonated spring
укр.	ukr.	reinforcement
ур.	ur.	natural landmark
ущ.	ushch.	canyon

Ф

ф.	fort	fort
факт.	fakt.	trading post (trading settlement)
фан.	fan.	plywood mill
фарф.	farf.	porcelain-pottery plant
фер.	fer.	farm

фз.	fz.	fanza [Chinese peasant house]
фирн.	firn.	firn field (snow field of grainy snow in high mountain areas)
фосф.	fosf.	phosphorite mine
фт.	ft.	fountain

Х

х.	kh.	farmstead
хут.	khut.	farmstead
хиж.	khizh.	cabin
хим.	khim.	chemical plant
хим.-фарм.	khim.-farm.	chemical-pharmaceutical plant
хлебн.	khlebn.	bread-baking plant
хлоп.	khlop.	cotton-growing sovkhoz, cotton ginning plant
холод.	kholod.	refrigerator
хр.	khr.	mountain ridge
хром.	khrom.	chromium mine
хруст.	khrust.	crystal works

Ц

Ц	Ts	cement-concrete (material for surfacing roads)
Ц.	Ts.	Central (part of proper name)
Центр.	Tsentr.	Central (part of proper name)
цвет.	tsvet.	nonferrous metallurgy (plant)
цем.	tsem.	cement plant

Ч

чаев.	Chayev.	tea-raising sovkhoz
чайн.	chayn.	tea factory
ч.мет.	ch.met.	iron and steel industry
чуг.	chug.	cast iron foundry

Ш

шах.	shakh.	mine
шив.	shiv.	shivera (rapids on Siberian rivers)
шк.	shk.	school
Шл.	Shl.	slag (material for road surface)
шл.	shl.	sluice
шпаг.	shpag.	binder twine factory
шт.	sht.	mining gallery
шиф.	shif.	slate plant

Щ

Щ	Shch	crushed stone (material for road surface
щел.	shchel.	alkaline spring

Э

элев.	elev.	elevator
эл.подст.	el.podst.	electrical substation
эл.-ст.	el.-st.	power plant
эл.-техн.	el.-tekhn.	electrotechnical plant
эф.-масл.	ef.-masl.	sovkhoz for crops for essential oils; plant for processing essential oils

Ю

ЮВ	YuV	Southeast
Юж.	Yuzh.	South (part of proper name)
ЮЗ	YuZ	Southwest
юр.	yur.	yourta (nomad's tent)

Я

яг.	yag.	berry patch

TABLE OF CONTENTS Page